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UTILIZATION OF MOLASSES

BY

O. P. TALWAR,

B.Sc., F.S.T.A. (I.), M.S.T.A. (U.S.A.), M.S.C.I. (LOND.),

*Late Chief Chemist to Messrs. Birla Brothers Sugar Factory,
Narkatinganj, Bihar,*

*Author of "Cane Sugar Factory Control",
'Pan Boiler's Hand Book', etc.*

AND

J. G. TALWAR, M.A.,

(Author of Pan Boiler's Hand Book.)

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PREFACE.

Indian Sugar Industry has made tremendous advance in India during the last two years. About two hundred big sugar factories have commenced working within a short period of two years.

This rapid development of the industry has increased automatically the bye-production of molasses to round about 3,75,000 tons per annum. The problem of utilization of molasses has already assumed serious proportions.

The authors have tried to put forth the various outlets for the disposal of molasses such as (1) Methylated spirit, (2) cattle food, (3) production of yeast, (4) Fertiliser, (5) Road surfacer, (6) cheap confectionary, (7) Fuel, (8) Power Alcohol.

The Production of Power Alcohol (Process of Manufacture, Machinery required, Cost of Manufacture, etc.,) has been well discussed.

But that is not all. The production of a well-known Potash Ash product from Molasses is the special feature of this book.

The authors are sure that the book will be of interest to those concerned in Sugar Industry. And that the reader will encourage the authors by giving them suggestions for making the book more useful.

10th May 1924.

AUTHORS.

CONTENTS.

PART I.

	PAGE
1. INTRODUCTION	1

Necessity of Utilization of Molasses.

CHAPTER I	3
-----------	---

Composition of Molasses.

Composition of Sugarcane Molasses, Xanthin bodies of cane molasses, Acid bodies of molasses, Carmelization product.

CHAPTER II	5
------------	---

Disposal of Molasses.

Disposal of Molasses :—(1) Methylated spirit (2) cattle food (3) Production of the yeast as a source of food (4) fertiliser (5) road-surfacers (6) cheap confectionary (7) fuel and (8) alcohol for power in partial substitution of petrol.

CHAPTER III	11
-------------	----

Manufacture of Motor Fuel.

Manufacture of Motor Fuel from Molasses, List of factories already producing Motor Spirit, usual process followed, the production of alcohol from fermented molasses and the conversion of part of alcohol into Ether-Sulphuric, Composition of Motor Fuel, the plant for the production of Motor fuel. Apparatus for the preparation of the (i) Wash from molasses (ii) the yeast cultures (iii) Fermentation of Wash (iv) Apparatus for distilling the alcohol (v) Apparatus for the conversion of alcohol into ether. Properties of Motor Spirit, Apparatus for producing absolute alcohol.

CHAPTER IV 15

Specification 1.

Equipment of a distillery for treating 10 tons of Molasses, with 50 per cent. Fermentable Sugar and producing a "Mixture of Alcohol and Ether."

Preparation of Wash, Preparation of the Ferments and Fermentations. Production of Alcohol—Ether Mixture, For the Alcohol, For Acid and Alkali, For accessories.

CHAPTER V 23

Specification 2.

Equipment for a distillery for Treating 10 tons of Molasses and producing Absolute Alcohol.

Preparation of Wash, Preparation of the Ferments and Fermentation, Production of Absolute Alcohol, Apparatus for continuous Dehydration.

CHAPTER VI 27

Molasses as Fertilizer.

Improved manner of utilising molasses to recover potash. Use of so recovered potash as Fertilizer, The Process used. Heating of Molasses, Burning of Molasses in a typical furnace, The product comprising the ash of the waste molasses. Operation of the Plant used. Analysis of the product, Working costs based on dealing with 1,000 Maunds of Molasses in 24 hours. Estimated yield and value of Product. Manufacture of Compound Fertilizers.

CHAPTER VII 39

Molasses—References.

References By-Products of Sugar Industry, Molasses, Molasses Alcohol, Molasses yeast, Molasses Fuel, Molasses Fertilizer, Molasses Feeding Stuff, Molasses (Carbon, Cyanide, Desaccharification), use of Bagasse, Bagasse, Fuel,

Bagasse-Mill-Board Paper and Fibre. Filter Press cake for cane wax etc.

PART II.

Cane Cultivation in India.

CHAPTER VIII

65

Method of Trench Cultivation, Total cost of making the trenches, Time of making trenches, Suitable size of trenches, The arrangement of trenches, use of manure, quantity of manure, use of oil-cake as manure, effect of liberally manuring the cane, The method of planting. Hoeing, Earthing of the canes. The importance of keeping the canes standing. Improved cultivation of Desi canes. Cultivation of Medium cane without trenches.

CHAPTER IX

83

"Cane Diseases."

Causes of cane diseases. How to distinguish the diseases. Diseases of stem, Diseases of sheath, Diseases of the leaf, Diseases of the root. (a) Red rot (b) Pine apple disease (c) Dongkellan Disease (d) Bibit Rot (e) Gumming disease, symptoms of the disease in young plants, The symptoms in crushing causes, (f) Sereh Disease etc. 99 etc.

INTRODUCTION.

The development of the sugar industry, under the regime of a policy of adequate protection, has been so remarkably rapid that within only two years of the date of grant of protection, a stage has been reached when India is able to produce practically all the sugar that it requires for consumption in the country. Such an extraordinarily rapid progress, however, has also brought in its train several problems of a very pressing nature which require the most careful and an anxious attention for the welfare of the industry. The most important of these is the problem of the proper utilization of the by-products of the industry, *viz.*, molasses and bagasse, etc.

Molasses is the most important by-product of the sugar industry, from the point of view of the factories as also of indigenous small scale manufacturers. It is often boiled again for making lower qualities of sugar, and the molasses finally obtained is exhausted and contains very little sucrose. Out of 100 maunds of cane about 9 per cent of sugar and 4 per cent. of

molasses are recovered by the factories and about 5·2 per cent. of sugar and 4·5 per cent. of molasses are recovered by the khand-saris.

The molasses produced by the factories and khandsaris in the past was consumed largely in the tobacco industry and in the manufacture of plain country spirits. The consumption of molasses in both these ways has fallen by more than 75 per cent. at the present time. While there has been such a heavy fall in the consumption of molasses, its production has naturally increased considerably since 1931, as a result of the establishment of a very large number of factories. The production of molasses in India was estimated at 2,69,000 tons in 1930-31 and 3,66,000 tons in 1931-32. In 1933-34 it is over 5,00,000 tons. The sudden increase in the production of molasses with a concomitant decrease in its consumption has created a problem of first rate importance and should engage the anxious attention of all sugar manufacturers.

CHAPTER I.

COMPOSITION OF SUGAR-CANE MOLASSES.

The composition of sugar-cane molasses is very variable, being dependent not only upon the composition of the cane but also, and to a much greater degree, upon the process of manufacture. The following table gives the approximate composition of third molasses :—

	per cent.		per cent.
Water	... 20'00	{ Silica, SiO_2	... 0'50
		{ Potash, K_2O	... 3'50
		{ Lime, CaO	... 1'50
		{ Magnesia, MgO	... 0'10
Ash	... 8'0	{ Phosphoric Acid, P_2O_5	0'20
		{ Sulphuric Acid, SO_3	... 1'60
		{ Chlorine, Cl	... 0'40
		{ Soda, iron etc., Na_2O , Fe_2O_3	... 0'20
Sugars	... 62'00	{ Sucrose	... 32'0
		{ Dextrose	... 14'0
		{ Levulose	... 16'0
		{ Albuminoids	... 0'30
		{ Amids (as asparagin)...	0'30
		{ Amido Acids	... 1'70
Nitrogenous bodies	3'00	{ Nitric Acid	... 0'15
Total N	= 0'5	{ Ammonia	... 0'02
		{ Xanthin bodies	... 0'30
		{ Other nitrogenous bodies	... 0'23

Soluble gums	... 2'0	{ Xylan, Arabon Pecton, etc.	... 2'0
Free Acids	... 2'0	{ Melassinic, Glutinic Saccharinic acids	
Combined Acids	... 3'0	{ etc.	... 5'00
Total	... 100	Total	... 100'0

The Xanthin bodies of cane-molasses are probably derived from the breaking up of the nucleo-proteids of the juice during clarification. A large part of the acid bodies of molasses as melassinic, glucinic and saccharinic, are not present in the juice, but are formed by the action of lime upon the reducing-sugars in the clarification.

Molasses also contains a small quantity of carmelization product, the amount of these depending upon the temperature of evaporation and boiling. Caramel is always formed by over-heating of cane-sugar and is a mixture of several dark-coloured bodies of uncertain composition.

— — —

CHAPTER II.

DISPOSAL OF MOLASSES.

The following are the outlets for the disposal of molasses:—(1) Methylated spirit, (2) cattla food, (3) production of the yeast as a source of food, (4) fertiliser, (5) road-sur-facer, (6) cheap confectionery, (7) fuel and (8) alcohol for power in partial substitution of petrol.

Methylated Spirit.—At the present time about a million gallons of methylated spirit is imported annually from Java. During the year 1932-33 the import was 8,56,800 gallons, valued at Rs. 8 lakhs. This latter represents the produce of about 4,45,000 maunds of molasses. An increase in the duty from $7\frac{1}{2}$ per cent. to about 25 per cent. would make it possible to shut out its import completely and to substitute the same from this country. A partial solution of the difficulty in finding an outlet for molasses can thus be found in the development of the Indian spirit industry.

Country Spirit.—The production of country spirits in India has decreased considerably during the last 12 years. About 1920, the quantity of molasses consumed for making potable spirit was 4 times the quantity used to-day. This is partly due to the Government's policy of reducing the consumption of potable spirituous liquor, and of deriving maximum revenue from a minimum consumption. We would like to see the production and consumption of liquor in India brought down to a minimum and therefore suggest that other avenues should be explored for utilization of molasses.

Cattle Food.—The scope for the use of molasses as cattle food does not appear to be great due to the difficulty in marketing combined with the traditional conservatism of owners of most of the cattles in India; as they are used to free grazing with hardly any expenditure on other food stuffs. But now that molasses can be given away without cost by factories, a certain amount can thus be consumed. This may solve the problem of disposal to a certain extent.

The use of molasses as a source of yeast

* Indian Sugar Mills Association.

is new to Indian ideas and is not likely to develop very much.

It is possible to use molasses as a fertiliser in its raw state, but our cultivators will have to be educated to its use and ample supplies of water would have to be provided in order to dilute the molasses before it could be put on the land. Used in a small quantity, it tends to improve the land. Sir Vijayaraghavachariar recently observed that he had seen molasses being used as manure. This avenue of use of molasses should therefore be explored and the Agricultural Departments should carry on research in regard to them.

Experiments show that one part of molasses mixed with five parts of water, can be sprinkled on land. It acts as a good manure. However, much also depends upon the nature of soil and the contents of the molasses produced.

Road Surfacers.—Another use though comparatively insignificant, to which molasses can be turned, is for road surfacing, by mixing it with a certain amount of pitch. Experiments in this direction should be carried on with a view to see how far this can be a commercial success in competition with other products.

Molasses was used for cheap confectionery in the villages, but since the decline in the price of gur and sugar, its consumption has considerably decreased.

Molasses can also be used as fuel. Same experiments were carried out in Java, and a few factories burnt a mixture of bagasse and molasses. In Australia several mills burnt molasses as a fuel in their furnaces. Molasses mixed in small proportion to bagasse burns well and produces profitable calories. This practice is followed in many centres in the Philippine Islands. A countless number of furnaces have been prepared for the burning of molasses alone in the Philippine Islands, but none of them to our knowledge has given satisfactory results. The possibilities of this however should be investigated in India.

POWER-ALCOHOL.

It is certain, however, that the best and most promising outlet in India for molasses would be in its manufacture of power-alcohol. The entire scientific world unanimously recognizes the fact that the fuel of the future for engines of internal combustion is alcohol. This can be produced from vegetable materials which

nature provides us generously and there is no danger that they will be exhausted in the course of time. The development of this is of considerable importance in the industrial development of this country; it is vital because of the possibility of providing the country with a motor fuel which is both cheap and easily obtainable. The manufacturer of sugar finds in molasses first class material for the production of alcohol.

The value of alcohol as a fuel for internal combustion engines has been recognised in various countries, *e. g.*, France, Germany and America. In Germany alcohol was used during the last world War in very great quantities by the army for motor transport, for which purpose it was mixed with benzol. The importance of alcohol as a fuel depends on its possibilities in the future as a substitute for kerosene or petroleum.

Power-alcohol can be produced in India and mixed with petrol in the proportion of one part of alcohol and three parts of petrol or 20 per cent. alcohol and 80 per cent. petrol. Several countries have in fact passed legislation making it imperative for petrol companies to use a certain percentage of alcohol with petrol.

In several countries the use of a specified mixture has been made compulsory ; in others, the principle has been adopted of requiring the oil companies, by legislation, to purchase annually a quantity of power-alcohol corresponding to a certain percentage of their imports and production of petrol and benzol ; and in some countries even of their kerosene. The adoption of this method leaves certain amount of latitude to the petrol distributing companies in distribution, and in practice the mixture is sold at a price somewhat lower than pure "light" petrol, in spite of the fact that it actually costs more. A more positive method of promoting the use of alcohol as a motor fuel is its exemption from duty as in Sweden.

CHAPTER III.

MANUFACTURE OF MOTOR FUEL FROM MOLASSES.

The motor fuel has for many years been produced successfully from molasses and Messrs. Egrot of Paris have supplied some of the largest plants for this purpose, among which may be mentioned the following :—

The Natal-Cane-By-products Co. Ltd.,
More-bank.

The Natalite Motor Spirit Co. Ltd.,
Nairobi.

The Wardle Engineering Company,
Manchester.

The usual process followed is the production of alcohol from fermented molasses and the conversion of part of alcohol into Ether-Sulphuric. The composition of motor fuel is by weight 55 per cent. alcohol at 95-96° G. L. and 45 per cent. Ether-Sulphuric.

The plant for the production of this motor-fuel comprises:—

(a) Apparatus for the preparation of the wash from molasses.

(b) Apparatus for the preparation of the yeast cultures.

(c) Fermentation of Wash.

(d) Apparatus for distilling the alcohol, and

(e) Apparatus for the conversion of alcohol into ether.

When treating 10 tons of molasses per 24 hours and assuring that the molasses contains 50 per cent. of fermentable sugar, an out-put of 550 gallons of motor fuel of the above composition is produced.

In many countries, experiments have, during the last years, been carried out with a motor fuel, composed of mixtures of alcohol 99·8 per cent. and petrol, in proportion of 25 per cent. alcohol and 75 per cent. petrol. This motor fuel is at the present time legally prescribed in Germany, France, Spain, and several other countries. It has considerable advantages. It gives approximately the same mileage as pure petrol, for the following reasons:—

(1) The alcohol acts as anti-knocking and is in this respect as efficacious as the poisonous lead compounds hitherto used.

(2) The alcohol avoids the formation of carbon in the cylinders.

(3) The alcohol makes the explosion less sudden and diminishes the strain imposed on the motor.

(4) This motor fuel has excellent starting qualities.

The apparatus for producing absolute alcohol is identical with the one described above. It is only necessary to add one apparatus for removing the water in the alcohol. This is made by a patented process which is working successfully in many large installations in Europe. It is possible by this process to produce an absolute alcohol at a much lower price than by its usual procedure.

Cane sugar molasses contain ordinarily 50 per cent. of fermentable sugar, which allows to obtain, when working in a rational manner; about 65 gallons of alcohol calculated at 100° per ton of molasses.

It is admitted that the material which Messrs Egrot utilises, is the most modern procedure of working and allows to obtain the maximum results.

The wash is prepared with molasses, water, and about 20 per cent. of spent wash previously passed through a cooler. The addition of spent wash has the object of bringing the wash, the acidity and the

nitrogenous matter necessary for a good fermentation. The prepared wash are sent to the fermentation wats, where yeast is added; this is cultivated with great care in a special apparatus and the wash that serves for the preservation of the yeast culture is carefully sterilised by the passage through one stiriliser, recuperator and cooler working automatically.

This last apparatus is replaced in small installations by a sterilization tank with all necessary accessories, such as heating and cooling coils, valves, special gauge, etc.

The fermentation tanks and the yeast tanks are equipped with cooling coils as well as exterior Water Spraying Coolers, in order to avoid any excess of the temperature, which is very harmful from the point of view of time which the fermentation takes, as well as the out-put and quality of the alcohol.

When the wash is maintained at the temperature in the neighbourhood of 85°F, the fermentation is vigorous and rapid.

The ready fermented wash is afterwards pumped to the feeding tank for the apparatus for a continuous distillation-rectification if one desires to obtain alcohol of 90—95° or rectified alcohol 96-97° G. L.

CHAPTER IV.

SPECIFICATION I.

The following is the equipment of a Distillery for treating 10 tons of Molasses, with 50 per cent Fermentable Sugar in twenty-four hours of a day and producing a "Mixture of Alcohol and Ether":—

A. PREPARATION OF WASH.

It constitutes the following:—

(1) *One Molasses Tank.*—It is made of mild steel and is vertical cylindrical shaped. It is open type, complete with accessories and possesses a capacity of about 200 gallons.

(2) *One Tank for Spent Wash.*—It is similar as No. 1 having capacity of 200 gallons.

(3) *One Tank of Copper.*—This is used for the separation of "Spent Wash."

(4) *One Multi-Tublar Cooler.*—This is meant for the cooling of the "Spent Wash."

(5) *One Tank for Preparation.*—There is one tank for the preparation of wash from molasses. It is made of mild steel and is vertical cylindrical shaped. It is of open type having a capacity of 900 gallons.

It has got complete arrangement for mixing by compressed air.

B. PREPARATION OF THE FERMENTS AND FERMENTATIONS.

(6) *One Sterilization Tank*—It is made of copper having interior block-tinned. It has got the capacity of about 200 gallons. It is complete with all the usual accessories including the following :—(i) Heating and cooling coil with valves, (ii) air and steam nozzles, (iii) safety valves, (iv) manometer, (v) gauge glass, (vi) thermometer, (vii) cocks and supports, etc.

(7) *One Tank for the Culture of Pure Yeast*.—It is made of copper, having interior block-tinned. It has capacity of 90 gallons. It is complete with all accessories such as (i) Air and steam nozzles, (ii) Piping, (iii) Aseptic recipients, (iv) gauge, (v) supports of cast iron, etc.

(8) *Two Tanks for Yeast*.—Each is made of mild steel and is vertical cylindrical shaped. It is open type having capacity of 55° gallons. It is complete with all usual accessories including cooling coil etc.

(9) *Six Fermentation Tanks*.—Each is made of mild steel and is vertical cylindric shape. It is open type. It has capacity of 5,000 gallons. It is complete with all

accessories including piping, valves, spraying coils of copper, etc.

C. PRODUCTION OF ALCOHOL-ETHER MIXTURE.

(10) *Apparatus for Treating Continuous Distillation.*—This equipment should be capable of treating fermented molasses wash of 7 to 8 per cent. and to produce per 24 hours 660 gallons of total alcohols, calculated at 100° of which 90—92 per cent. of purified alcohol of 95-96 per cent. G. L. The rest products of head and tail of bad taste : this apparatus consists of :—

(a) One cylindrical distillation column of copper executed in parts. Each part consists of rivetted plates with (i) bubbling covers egg-shaped, (ii) anti-froth device in copper, (iii) mantle of copper, (iv) syphon and all accessories.

(b) One concentration column of copper.

(c) One finishing column for the retrogradation from the concentration column.

(d) One Heater made of copper.

(e) One gas Cooler, which is tubular and is made of copper.

(f) Coolers and proof glasses for alcohol. This is complete with different impurities and the spent wash.

(g) One Automatic Regulator for the heating steam. It is complete with piping and valves for the connection of the different parts of the apparatus.

(11) *One Continuous Apparatus.*—This is meant for treating the rectified alcohol 95-96° G. L. produced by the above-mentioned apparatus and giving per 24 hours 550 gallons of alcohol-ether. This apparatus consists of :—

(a) One Regulating Tank for feeding the super-heater with alcohol.

(b) One Super-Heater. It is made of steel suitable for 50 lbs. pressure and is complete with copper coil and steam trap, etc.

(c) One Etrerifying apparatus (System Annartone). This is made of mild steel and has interior cover with lead. It is heated by steam jacket with piping for (i) alcohol, (ii) acid, (iii) steam, (iv) crude ether, (v) thermometer, etc.

(d) *One Saturator.*—It is made of copper, and consists of several plates. An alkaline solution passes over these plates.

This is to remove excess acid and impurities from the ether vapours.

(e) *One Construction Column*.—It is made of copper and is meant for the concentration of ether and alcohol.

(f) *One Tubular Condenser*.—It is made of copper.

(g) *One Finishing Column*.—This is made of copper and is meant for the complete separation of alcohol.

(h) *One Cooler with mild steel tank*.

(i) *Two interior copper coils*.—One of them is meant for the cooling of the gas.

(j) *One Cooler*.—It is meant for the spent wash.

(k) *Proof Glasses*.—These are suitable for the mixture of ether and the spent wash.

(l) *Various Thermometers and Pressure Gauges*.

D. FOR THE ALCOHOL.

(12) *One Pump*.—It is duplex type and is made of cast iron. It is complete with all accessories of bronze.

(13) *One Feeding Tank*.—It is made of mild steel and is complete with all accessories.

E. ACID AND ALKALI.

(14) *One Tank for Sulphuric Acid.*—It is fitted with cover and an over-flow.

(15) *One Monte-Acid of Cast Iron.*—This is operated by compressed air.

(16) *One Tank of Mild Steel.*—This is used for the preparation of alkaline solution.

(17) *One Storage Tank.*—This is made of mild steel and is meant for alkaline solution.

(18) *One Monte-Alkali.*—It is made of cast iron and is operated by compressed air. It is complete with piping valves for the connection of the various apparatus.

F. ACCESSORIES.

(19) *One Boiler, Multitubular type.*—It is suitable for producing 1,300 lbs. of steam per hour at 150 lbs. per sq. inch with all accessories and safety device, etc.

(20) *Two Duplex Feed Pumps.*—Each is made of cast iron and is complete with all accessories in bronze. One will be as a spare.

(21) *One Compressed air Plant.*—This comprises (i) one air compressor which is steam drive, (ii) one receiver with accessories such as (a) pressure gauge, (b) regula-

tion cocks, (c) safety valve, etc., (d) one air filter of copper.

(22) *One Duplex Pump*.—It is steam driven and is meant for molasses. It has got output of 200 gallons per hour. It is complete with all accessories. Its pumping portion is in bronze.

(23) *One Duplex Pump*.—It is meant for fermented wash. It is suitable for 450 gallons of output per hour. Its pumping portion is in bronze

(24) *One Duplex Pump*.—It is meant for the supply of cold water. It is made of cast iron and is complete with all accessories in bronze. It has output of 3,000 gallons per hour.

(25) *One Storage Tank*.—It is meant for fermented wash and is vertical cylindric shaped. It is open type. It has capacity of 550 gallons and is complete with all accessories.

(26) *One Tank of Cold Water*.—It is made of mild steel and is open type. It has the capacity of 1,750 gallons.

(27) *One Tank for Hot Water*.—This water comes from the condenser and steam traps, some of this water is also used for the utilisation in feeding the boiler. It has the capacity of 330 gallons.

(28) *One Steam Receiver.*—It is made of mild steel and is meant for receiving steam from the duplex pumps and utilizing the steam for heating the apparatus for continuous distillation.

(29) *Piping and valves.*—There are many valves and piping to connect the different parts of the installation. The piping shall be in copper for (a) molasses, (b) spent wash, (c) fermented wash and (d) alcohol. Steel and cast iron piping can be used for water, steam, and compressed air.

CHAPTER V.

SPECIFICATION 2.

Equipment for a Distillery for Treating 10 tons of Molasses and producing Absolute Alcohol.

This equipment consists of:—

A. PREPARATION OF WASH.

(1) It is the same as specification No. 1, items 1 to 5.

B. PREPARATION OF THE FERMENTS AND FERMENTATION.

(2) It is same as specification No. 1, items 6 to 9.

C. PRODUCTION OF ABSOLUTE ALCOHOL.

(3) *One apparatus for distillation and direct rectification.*—It is capable of treating fermented wash from molasses, with 7 to 8 per cent. and producing per 24 hours 660 gallons of alcohol, calculated at 100° of which 90—92 per cent. is rectified extra neutral, and 96—97 per cent. G. L. The rest in head and tail is produced of bad taste. This apparatus consists of:—

(a) One Distillation column which is cylindrical and is made in red copper,

executed in parts, consisting of plates with bubbling covers. These plates are egg-shaped. There is also a froth removing device made of copper and a syphon for removing the spent wash. It is all complete with usual accessories.

(b) *One column for purifying the fermented wash.*—This is made in copper and has got the same construction as above described.

(c) Upper part in copper with plates, with dented tunnels for the concentration and extraction of the head products.

(d) One tubular Condenser of Copper.

(e) *One Rectification Column.*—It is made of copper. It is fitted with plates and with dented tunnels for the extraction of products of medium taste and tail products.

(f) *One Finishing Column.*—This is meant for the retrogradation and is made of copper.

(g) *One Heater.*—It is made of copper.

(h) *One Tubular Condenser.*—It is also made of copper.

(i) *One Cooler.*—It is meant for the alcohol.

(j) Coil of copper placed in tank of mild steel.

(k) One automatic regulator for the steam.

(l) Prooved glasses for the rectified alcohol and the bad taste alcohol.

(m) Cooler and proof glasses for the rectifications of the spent wash.

(n) Thermometers, pressure gauges, piping and valves for the connection of the above apparatus are required.

(4) *One Apparatus for Continuous Dehydration.*—This is used (by the procedure “HIAG” patented) for treating rectified neutral alcohol obtained in the distillation apparatus. This is capable of producing (per 24 hours) 600 gallons of absolute alcohol 99·8 per cent. This apparatus is complete with all accessories.

D. ACCESSORIES.

5. One Multi-tubular Boiler for the production of 1,600 lbs. of steam per hour (150 lbs pressure). It is complete with all accessories and safety device.

(6) *One Super Heater.*—This is meant for heating the steam up to 320°C.

(7) Two Duplex Feed Pumps.

(8) *One Compressed Air Plant.*—This is similar to item No. 21 of specification No. 1.

(9) *Four Duplex Pumps.*—They are similar as described previously.

(10) Three Tanks.

(11) One Steam Receiver.

(12) *Piping and Valves*.—These are the usual requirements.

MOTOR SPIRIT DISTILLERY.

There is one by name "The Uganda Motor Spirit Distillery" in British East Africa. This distilling plant was supplied by Messrs Lepage Urbain & Co. of Paris. This consists of one alcohol distillation column capable to manufacture 40 gallons per hour of pure alcohol of the strength of 96 per cent. by volume. There is another column which is Ether section and is capable to prepare about 18 gallons of Ether per hour. The Alcohol and the Ether are mixed together in proportion of 65 and 35 and the resulting mixture is a suitable Motor spirit.

CHAPTER VI.

MOLASSES DISPOSAL

By

W. J. ALCOCK & Co.

This invention relates to an improved manner of utilising waste molasses to recover the potash therefrom, and it includes an improved type of furnace and plant for treating the molasses to produce ash with a high content of potash and also the ash which is produced thereby.

The invention also includes a fertilizer which is produced with this ash having a large content of potash, together with lime phosphates and nitrogen.

The rapid increase of the Indian Cane Sugar Industry has increased automatically the bye-product production of molasses to round about 3,75,000 tons per annum. The established outlets for molasses are well filled, leaving a heavy surplus of the bye-product which is without commercial value, whereas before the recent rapid development of the Cane Sugar Industry molasses sold at round Rs. 2 per maund at the factory.

The surplus could be absorbed for the manufacture of power alcohol for use in motor driven vehicles. But this entails large capital expenditure.

The Molasses could be used as a fertilizer in its raw state, but possibly years would elapse before the Indian cultivator could be educated to its use and ample supplies of water would be required to dilute the molasses before it could be put on the land.

At the moment the Cane Sugar Industry is faced with the serious problem of the disposal of its bye-product.

If the molasses is fed to an adjacent river or water-course the water will be polluted. If run into pits a serious nuisance to the neighbourhood arises, so much so that it may come within the Public Health Act and may cause the closing of the factory.

The process, furnace and plant, according to the present invention, obviates nuisance and makes provision for returning the valuable potassic content of molasses in a readily assimilable form to the land, and may be used for the fertilization of sugarcane or other crops.

It is well known that potash is necessary to plant life to enable starch, sugar cellulose and other carbo-hydrates to be produced.

Potash plays a large part in the development of leaves and woody parts of the stems of plants and gives the plant more resistance to attacks of fungous diseases, or the like.

Sugarcane on an average extracts from the soil 100 to 150 pounds more or less of potash per acre and it is essential that this should be replaced either by potash recovered from molasses or fresh sources, if the land is not to be impoverished with the resultant low yield of crops

Based on the fact that molasses has a content of round 9% of ash and this ash has a potash content of 34%, or 3% of available fertilizer on the weight of molasses, the process later described enables a return to the land of 50 pounds of potash for every 100 maunds of cane grown, which is a return of practically half of the potash which is extracted by the plant.

Further, it is possible by drying the filter press cake in the sugar factory (the cake contains lime phosphates and nitrogen) and by mixing same with the potassic pro-

ducts from molasses to produce at the factory a valuable compound fertilizer for application to all crops. As at the moment molasses and filter press cake have practically no value, the fertilizer can be manufactured and sold to the agriculturist at much lower rates than those ruling for imported fertilizers and leave a profit to the factory.

Molasses has a calorific value round 4,000 to 4,400 B. T. V. and may be burnt, but whilst this method is applicable to the raising of steam in steam boilers, the potash contents pass away in flue gases owing to the fact that potash volatilizes at round about 1,430° Fahr.

One object of the invention is to produce a furnace to burn molasses at the lowest possible temperature and recover the highest possible yield of potash.

The invention comprises a manner of utilising waste molasses to recover the potash therefrom which consists in causing the same to be fed in drops or threads from a rotating distributor into a furnace where the falling molasses is consumed at the lowest possible burning temperature to conserve the potash content, the ash being withdrawn, preferably whilst still red hot

and allowed to cool outside the furnace, to be used as a fertilizer.

In this manner of dealing with the molasses, the molasses is preferably pre-heated by means of a steam grid, or the equivalent, to approximately 185° Fahr. before feeding to the distributing drum, and the temperature of combustion in the furnace and in the flues is limited as far as possible to a temperature which does not exceed 1,430° Fahr. in order to prevent as far as possible the volatilization of the potash.

The invention also includes a plant for burning waste molasses from cane sugar factories or gur refineries comprising a furnace into which the said waste product, suitably pre-heated, is introduced into or upon a revolving drum from which it falls as drops or threads to be burned as it falls.

This revolving distributing drum is preferably mounted on a water-cooled hollow shaft through which cooling water may be caused to flow.

In the preferred manner of carrying out the invention the revolving distributing drum is provided with outwardly projecting points from which the molasses may drip or be thrown off in drops or threads so that

as it falls it will burn. This distributing drum may comprise a cylindrical or tubular central part with flanged ends or end discs forming projecting end flanges to said central part, a multiplicity of spaced longitudinal angles fixed to said central part, and a series of spikes connected to said angles.

In the preferred form of construction the distributing drum has projecting longitudinal ribs or ridges thereon, for example ridges formed by the outwardly projecting legs of angle iron sections secured to the outer periphery of a cylindrical or tubular central part, said ribs or ridges forming hollows into which the molasses is fed from above and from which the molasses is tipped out as the drum is rotated, said molasses in being so tipped flowing off mainly from the projecting spikes arranged along the crests formed by the outer edges of the outwardly projecting legs of the angles. In order to direct the molasses to these spikes, grooves or guide surfaces may be provided on the projecting legs of the angles referred to above, and these be adapted to lead the molasses to the roots of the spikes, so that it will drop off or fall from the spikes in individual drops or strings.

These guide surfaces may be formed on the main longitudinal angles by means of small angles secured to the larger angles and sloping from points adjacent to the drum surface midway between pairs of spikes on each main angle to the roots of said spikes adjacent to the crests or outer edges of said main angles, with the object that as the distributing drum rotates the tendency will be for the molasses to be directed towards the spikes, to be thrown off by the spikes in drops or strings.

In a plant for burning molasses, the invention also includes the combination with a furnace, of distributing means for leading heated molasses to the furnace and for introducing the same into the furnace, said distributing means comprising a series of spaced nozzles or the like for dropping the molasses upon a revolvable drum inside the furnace.

A damper may be provided, preferably placed between the furnace chamber and the flue for carrying off the waste gases of combustion, for the purpose of controlling the draught and the rate of combustion.

The invention also includes a plant for burning waste molasses to recover the potash in the ash, comprising a battery of

furnaces having means for supplying molasses, preferably in heated condition, through an overhead piping system to the furnaces through distributing heads or nozzles or the like, preferably controlled by valves, distributing drums or the equivalent in the furnaces which are capable of rotation to distribute and to cause the molasses to fall as drops or strings through the burning zones of the furnaces ; a system for water cooling the bearings and other parts of the distributing drums ; shafting and gearing belting or the like to drive the distributing drums ; flues to carry off the gases of combustion ; dampers or means to control the draught ; ashpits for the reception of the ash, and floors upon which the ash may be raked out.

The invention also includes a new product comprising the ash of waste molasses when burnt in a manner or in a furnace as described above, the said burning having been effected at the lowest possible practical temperature to conserve the potash content.

The invention also includes a fertilizer comprising ash from waste molasses, as described above, the said ash having been broken up or otherwise suitably treated by screening or the like and being mixed with

dry powdered filter press cake from the cane sugar factory to produce a compound fertilizer suitable for direct application to the soil.

The Plant is operated as follows :—The Molasses is pumped from the main Molasses Tanks or may be run by gravity from your Overhead Molasses Tanks to the Pre-Heating and Feed Tank against the Disposal Plant, here it is heated with steam to render it to fluid for passing through the feed nozzles on each furnace.

After the Furnaces have been sufficiently heated up at the start with firewood, the Molasses burn by themselves after passing over the Rotary Distribution Drum, which is of special design for this purpose, the Molasses burns to a grey or brown ash : it is then raked out on to a cooling floor and allowed to cool off before screening and bagging.

Analysis :—The Product contains on an average 31 per cent. of potash together with lime, soda, etc. The Product is dry and powdery, we anticipate no difficulty in disposing of it, as potash is such a valuable fertilizer and required for practically all kinds of crops.

Composition :—

Potash (K_2O)	... 30.32 %
existing as :—	
Potassium Carbonate (K_2CO_3)	... 18.66 %
Potassium Sulphate (K_2SO_4)	... 18.80 „
Potassium Chloride (KCl)	... 11.63 „
Calcium Carbonate	... 13.55 „
Insoluble Silicious matter	... 18.04 „
Oxide of Iron and Alumina	... 4.12 „
Phosphoric acid (P_2O_5)	... 1.50 „
Lime (combined)	... 6.57 „
Magnesia	... 2.92 „
Free and Combined water, etc.	... 4.21 „
	100.00

The value of this sample as a fertiliser can be obtained from the following results .—

Potash (K_2O)	... 30.32 %
Phosphoric acid (P_2O_5)	... 1.50 „
Nitrogen	... Nill.

From the analysis report you will see that the Ash is of particular fertiliser value for sugarcane land and has been enquired for by the Directors of Agriculture for Bengal, Punjab, and Central Provinces besides private firms.

Working Costs Based on Dealing with 1,000 Maunds of Molasses in 24 Hours.

	Cost per Md. Molasses.
Labour	... 72 annas.
Steam for Power	... 23 „
Repairs	... 25 „
Depreciation	... 30 „
	... 150 annas.

One and a half anna per Maund of Molasses

Estimated Yield and Value of Product.

Taking the average Ash contents of Molasses to be round 9 per cent., 100 maunds of Molasses will yield 9 maunds of Ash, that may have an approximate Potash content of 34 per cent. or 3 per cent. of available Fertilizer value. Such a product based upon other Potash Product will have a value of Rs. 2-12-0 per maund at Factory. Reduced to one maund of Molasses 3-96 annas, therefore :—

Estimated value of product

per maund of Molasses	... 3-96 annas.
Cost of Treatment	... 1-50 annas.

Estimated Profit	... 2-46 annas.
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Say, 2½ annas per maund treated.

A Proposal to Manufacture Compound Fertilizers.

We would specially like to draw your attention to the possibility of your making a Compound Fertilizer, by making use of your Filter Press Cake which is at present a valueless article, and with a further addition of sulphate of ammonia you would be able to market a product containing all the necessary elements for fertilization of crops, namely—Potash, Phosphate of Lime and Nitrogen from the sulphate of ammonia.

Compound Fertilizers : it should be possible to arrange to dry the cake coming from the Filter Presses by the waste heat of the Molasses Furnaces, this dried cake on an average contains about 7-8% of Calcium Phosphate in a very assimilable form to plant life, this dried cake could be mixed with the Potash Product and marketed as a compound fertilizer, and if necessary Sulphate of Ammonia could be incorporated, resulting in a first class compound which should find a ready sale for practically all crops.

We should be pleased to advise you on this point if you should desire.

CHAPTER VII.

REFERENCES.

BY-PRODUCTS.

BY-PRODUCTS—GENERAL.

By-products of the Sugar Industry.—W. E. Cross ; Rev. ind. agr. Tucuman, 13, 81—128 (1922) C. A., 17, 3426.

Progress made in Sugar Manufacture and By-product utilization in Hawaii.—Anon. I. S. J., 25, 85—8 (1923). C. A., 17, 2651.

Report on Progress made in Sugar Manufacture and utilization of By-products in Hawaii.—Wr. H. Duker, W. P. Naquin and S. S. Peck ; I. S. J., 22, 207.

The Australian Sugar Industry.—T. D. Chataway ; I. S. J., 26, 301.

The manufacture of Sugar and utilization of By-products.—South African Experiment Station Library ; E. L. G., 101, 762.

Glycerine from Sugar.—South African Experiment Station Library ; E. L. G. 101, p. 2.

The following books may be consulted :—

1. *The Manufacture of Cane Sugar.*—By L. Jones and F. I. Scard.

2. *The Carbohydrates and Alcohol*.—By S. Rideal and Associates.

3. *Industrial Alcohol*.—By J. G. McIntosh.

4. *Sugar*.—By Geoffrey Fairrie.

5. *Dictionary of Applied Chemistry*.—By Thorpe (Sugar By-products.)

6. *The Manufacture of Sugar from the Cane and Beet*; G. H. P. Heriot.

7. *Cane Sugar and its Manufacture*.—By H. G. Prinsen Geerligs.

8. *Recovery and use of waste Products*.—By J. B. C. Kershaw.

(1) *Ind. Chemist* 1, 434—7 (1925). C. A. 20, 634.

(2) *The Chemical Industries*.—*Ind. Chemist* 1, 492—4 (1925). C. A. 20, 634.

(3) *In Paper and Sugar Industries*.—*Ind. Chemist* 1, 543—7 (1925). C. A. 20, 955.

MOLASSES-GENERAL.

Summary of Technical Methods for the Utilization of Molasses.—S. A. Experiment Station Library; Pamp. 1617.

Utilization of Molasses.—S. A. Experiment Station Library; Pamp. 1781.

Utilization of Molasses.—H. Arnstein; S. A. Experiment Station Library. E. L. G., pp. 54, 67, 89, 93, 100, 200, 209, 533, 569, 573.

Low-grade Sugarcane Molasses or Blackstrap.—W. H. Dalrymple ; S. A. Experiment Station Library Pamp. 1043.

Composition and utilization of Exhausted Molasses.—H. A. Tempany and C. D. D'Avoine ; S. A. Experiment Station Library, Pamp. 1121.

Poisoned Molasses for the Destruction of Noctuid Moths.—E. H. Strickland, J. Econ. Entomology 15, 214—20 (1922). C. A. 16, 3726.

Molasses (Purification for use as food).—H. C. Cutler ; Brit. 169, 113. No. 8, 1920.

Apparatus for the Purification of Molasses.—H. Kume, Jap. 38,008, Feb. 14, 1921.

The Character and Composition of Sugar cane Molasses.—W. D. Helderman. Arch. Suikerind 29, 1249—54 (1921), C. A. 657.

Utilization of Final Molasses.—R. Carpenter. Facts about Sugar 14, 390—1, 392 (1922).

The By-products Process.—Ed. Kurek. Zuckerind ; Czechoslovak Rep. 46, 308. Chem. Zentr. 1922 IV. 58. C. A. 17, 2792.

Report on Meeting of the Society of Technical Advisers of the Java Sugar Industry, April, 1922. Meeting of the

Chem. Section. Arch. Suikerind 30, part 3, 121—57 (1922). C. A., 17, 1161.

Sugarcane Molasses.—Friedrich Wendel. Chem. Zentr. 1922. IV. 1058. C. A., 17, 2791.

Summary of Technical Methods for the utilization of Molasses collated from Patent Literature. Anon. Bur. of Standards, Arc, No. 145, 72 pp. (1924).

Utilization of Waste Molasses.—H. J. Carsten. Philippine Journal of Science. 17, No. 4, 395—407, I. S. J. XXIII 295.

Treating Molasses.—A. Wohl; U. S. 1,499, 134, C. A. 17, 2371.

Utilization of Mauritius Molasses.—By H. A. Tempany; Dept. Agr. Mauritius. Bulletin No. 21, I. S. J. XXIII. 410.

World Production and World Trade in Molasses.—Anon. Arch. Suikerind 34, 429—32 (1926), C. A. 20, 2918.

Valuable Products from Java Molasses.—M. Rups; Arch. Suikerind 34, 845—56 (1925). C. A. 21, 190.

Valuable Products from Java Molasses.—D. Van OS. Arch. Suikerind 35, 303—7 (1927). C. A. 21, 2572.

MOLASSES-ALCOHOL.

Production of Alcohol from Molasses.—By W. L. Owen; Facts about Sugar, 1922;

14, 478—479 ; 15, 10—11, 54-55, 92-93.

Acid Requirements in the Fermentation of Molasses (Blackstrap).—By W. L. Owen and J. D. Bond ; Indust and Eng. Chem. 1924, 16, No. 4, 387--392, I. S. J. XXVI. 446.

The cause of the low yield of Alcohol in the Fermentation of Cane Molasses.—By D. N. Gupta and E. R. Watson ; I. S. J. XXVI, 591.

Motor Fuel from Molasses.—S. A. Experiment Station Library ; Pamp. 843.

Alcohol Motor Fuel from Molasses.—E G. Free-land ; S. A. Experimental Library, Pamp. 1207.

Manufacture of Alcohol from Molasses.—By E. Humboldt ; S. A. Experiment Station Library, Pamp. 101, 86.

Utilization of Molasses in the Manufacture of Motor Fuel.—By H. Arnstein ; S. A. Experiment Station Library ; E. L. G. 148—157.

A Report on the Manufacture of Industrial Alcohol from Hawaiian Molasses.—By W. L. McCleery and H. P. Agee ; La, Planter 69, 449-50, 468—70, 487—90. C. A., 17, 1105.

The Utilization Molasses, XII.—The Manufacture of Distilled and Molasses

Vinegar. H. Arnstein ; La. Planter 71-2, 91-2, (1923). C. A., 17, 3744.

Waste Molasses for Fermentation Purposes.—H. A. Cook ; Sugar 25, 374—9 (1923). C. A., 17, 2933.

The Motor Alcohol Distillery.—By J. P. Foster ; Sugar News 3, 73—9 (1922) C. A. 17, 2765.

Making Alcohol from Waste Molasses.—D. Jessurun ; Sugar 25, 173—5 (1923). C. A. 17, 2164.

Alcohol as Fuel and its Production in Italy.—By Guiseppe Mezzadrolì. Giorn Chem. Ind. applicata 5, 125—8 (1923).

Alcohol from Cane Blackstraps.—W. L. Owen and J. D. Bond ; Ind. Eng. Chem., 16, 387—92 (1924). C. A. 18, 1545.

Alcohol yields from Molasses.—By H. A. Tempany ; Sugar 26, 189-90 (1924). C. A. 19, 374.

Yield of Motor Fuel from Molasses.—W. I. McCleery and H. P. Agee ; Sugar 26, 191-2 (1924). C. A. 19, 374.

Some Factors Affecting the Efficiency of Molasses Distillery.—By W. L. Owen ; Lonsiana Planter Reference Book, II 1924, 60-3. C. A., 19, 1471.

Use of Cane Molasses for Manufacture of Motor Fuel.—E. C. Freeland ; Ind. Eng.

Chem. 17, 615—21 (1925). C. A, 19, 2119.

Molasses as a Source of Alcohol.—Anon. I. S. J ; XXII. 430.

Molasses Distillation.—By A. Meyer; Arch. Suikerind 33, 562—4 (1925). C. A, 19, 3142.

Molasses Utilization as Fuel; for Recovery of Potash; for Manufacture of Motor spirit and for production of a Camp Fuel.—Ry S. S. Peck. Paper presented to 17th Ann. Meet, Hawaii Chemists' Asseo. I. S. J. XXII, 173.

Power Alcohol and Sugar Production.—Anon. Austral. Sug. J. Vol. 16 (1925), pp. 821—826. Facts About Sugar XX, (1925), 514.

Fermentation of Cane Molasses.—By E. Kayser; Ann. Falsif. 1927. 20, 326—328. B. C. A. B. 1927, 666.

Alcohol Motor Fuel.—Benzol Verband Ges (patent). I. S. J., XXIX 49 (1925).

Alcohol Motor Fuel.—By E. V. Bereslowsky (patent) I. S. J., XXIX. 49 (1926).

MOLASSES—YEAST.

Molasses.—Yeast Vereinigte Mantner-sche Preeshefe Fabriken Ges, Brit, 196, 926. April 26, 1923. C. A. 17, 3744.

The Use of Cane Molasses in Yeast

Growing.—By G. Wendel; Z. Spiriturind 45, 306 (1922). C. A., 17, 3744.

Yeast.—By R. Hamburger and S. Kaesy. Brit. 209, 034. October 6, 1923.

Yeast.—By Vereinigte Mantnersche Preeshefe.—Fabriken Ges. Brit. 234, 843. May 30, 1924. C. A.; 20, 795.

MOLASSES—FUEL.

Reduction of Fuel Costs at Puunene Mill (T. H.)—Report of Committee on Boiler Equipment of the Assoc. of Hawaiian Sug. Tech. 1923. I. S. J. XXVI, 388.

The Molasses Furnace as a Heat Unit and Potash Extractor.—By J. Wyllie; Sugar News 4, 161-2 (1923).

Report of the Meeting of the Assoc. of Technical Advisors of the Java Sugar Industry, Joint Meeting of Technical and Chemical Sections. Anon. Arch. Suikerind 31, Part 4, 51, 177 (1923).

The Use of Molasses as Supplementary Fuel.—Arch Suikerind 32, 359—67 (1924), C. A.; 18, 2261. H. J. Kaufman.

The Use of Molasses as Supplementary Fuel.—Anon. Arch. Suikerind 32, 459-60 (1924). C. A., 18, 2821.

Use of Molasses as Fuel.—By G. J. Schott And Ph Van Harreveld; Arch. Suikerind

32. Mededeel Proefstation Java. Suikerind No. 14, 449—63 (1924). C. A., 19, 415.

Molasses as Fuel at the Sugar Factory Pærwokerto (Java).—By C. C. W. Van Ganswijk. Arch. Suikerind 32, 1065—8 (1924). C. A., 19, 415.

Burning Molasses Mixed with Bagasse.—By Ph. Van Harreveld Arch. Suikerind 32, 1095—6 (1924) C. A., 19, 415.

Use of molasses as a Fuel and Preparation of Potash from the Ash obtained.—By G. E. G. Van Stietz. Arch. Siukerind 28, No. 15, 519—533. I. S. J. XXII. 467.

Molasses as Boiler Fuel.—By E. W. Greene. I. S. J. XXV. 46.

Utilization of Waste Molasses as Fuel and Recovery of Potash from the Ashes.—By R. Renton Hind. Sugar News. 1923, 4. No. 1, 16—19.

Use of molasses as Boiler Fuel in Cane Sugar Fuctory.—By J. Wyllie. Sugar News, 1923. No. 4, 161—162. I. S. J., XXV. 433.

Molasses, Utilization as Fuel, for Recovery of Potash, for Manufacture of Motor Spirit and for Production of a Camp Fuel.—By S. S. Peck. Paper presented to 17th Ann. Meet, Hawa Chemists' Assoc. I. S. J ; XXII. 173.

Molasses Used as Fuel.—Anon. Arch. Suikerind 35, 538—42 (1927). C. A., 21, 3283.

MOLASSES—FERTILIZER.

The Use of Molasses as Fertilizer in Java.—J. Knyper. Archief; 1926, 34. No. 4, 95—98, I. S. J., XXVII. 277.

The Influence of Molasses on Nitrification in Cane Soils.—By S. S. Peck; S. A. Experiment Station Library, Pamp. 1359.

The Use of Molasses as Fertilizer.—By L. Fanque. Rev. Agr. Maurice 1, 179-182 (1922). C. A., 17, 1103.

The use of Molasses as Fertilizer in Mauritius.—By P. de Sorney. Rev. Agr. Maurice 1, 229-40 (1922). C. A.; 17, 1103.

Effect of Molasses on the Growth of Cane.—By H. A. Tempany and F. Gerand. Rev. Agr. Maurice 1, No. 10, 169-80 (1922). C. A.; 18, 145.

Molasses as a Fertilizer for Cane.—By H. A. Tempany and F. Gerand. Sugar 26, 355-7, 391 (1925). C. A.; 19, 1635.

Use of Molasses as Manure in Mauritius.—P. de Sornay. Bull. Assoc. Chem. Sucr. France 37, No. 6, 223, I. S. J. XXII. 469.

The use of Molasses for Soil Amelioration.—J. Kuyper. Arch. Sinkering 34, 95-9 (1926). C. A. 20, 1917.

Integral Utilization of the Residue of Molasses as Nitrogen.—E. Cerasoli. Giden. Chim. Ind. Applicata 8, 61-2 (1925). C. A. ; 20, 3357.

Fertilizer.—R. R. Hind. U. S. 1,583,151. C. A. ; 20, 2043.

Preparation of a Product (fertilizer) from Molasses. By W. H. Dickerson. U. S. P. 1,631,252. B. C. A. B., 1927, 611.

MOLASSES—FEEDING STUFF.

Feeding Blackstrap Molasses to young Calves.—By R. C. Calloway ; S. A. Experiment Station Library, Pamp. 1020.

Cane and Beet Molasses for Fattening Lambs.—By J. M. Eovard and C. C. Culberts ; Iowa State Coll. Agr. Experiment Station Bull., 215, 371-400 (1923). C. A., 18, 103.

Analysis of Molasses Feeds.—Anon. Bull. Assoc. Chim. Sucr. Dist. 40, 491—6 (1923). C. A., 18, 135.

Feeds Containing Molasses.—Rothea. Ann. Fals. 15, 339—53, 408—19, 464—70. C. A., 17, 1089.

The Analysis of Molasses Feeds.—A. Minet and R. Jacques. Ann. Fals. 16, 231—2 (1923). C. A., 17, 2756.

Molasses for Feeding Purposes.—H. C. S. de Whalley. J. Soc. Chem. Ind. 41, 169—70 R. (1922). C. A., 16, 2185.

Food Value of Molasses; Molasses as Stock Food.—By J. C. Brunnich. Queensland Agr. J. 16, II. 157 (1924). C. A., 19, 1606.

The Apparent Digestibility of Low Protein Rations by Dairy cows.—By A. E. Perkins and C. F. Monroë. J. Dairy Sci. 8, 405—14 (1925). C. A., 20, 225.

Molasses (purification for use as food).—By H. C. Cutler. Brit. 169, 113, No. 8, 1920.

MOLASSES—POTASH.

Potassium Salts from Molasses spent Liquors.—By W. Iwanicki. Chem. Zentr. 1924, 11, 2298—9, Pryemysl Chem. 8, 149—61. C. A., 19, 3033.

Potassium Values from Residues of Molasses Fermentation and other organic Waste Materials.—By H. A. Niebecker. U. S. 1, 555, 512, C. A., 19, 3570.

Use of Molasses as a Fuel and Preparation of Potash from the Ash obtained.—G. E. G. von Stietz. Arch. Sinkerind 28. No. 15, 519—33. I. S. J., XXII. 467.

Recovery of Potash from Waste Molasses.—By Raymond Elliott. Reports Assoc. Haw. Sug. Tech. 1st Ann. Mtg., Nov., 1922. I. S. J., XXV. 606.

Utilization of Waste Molasses as a Fuel, and the Recovery of Potash from the Ashes.—By R. Renton Hind. Sugar News, 1923-4 No. 1, 16—19.

Molasses, Utilization as Fuel, for Recovery of Potash, for Manufacture of Motor Spirit and for Production of a Camp Fuel.—By S. S. Peck. Paper presented to 17th Ann. Meet. Hawa, Chemists' Assoc. I. S. J. XXII. 173.

MOLASSES—CARBON.

Decolorising Carbon.—A. A. Backhans. U. S. 1, 510, 131, C. A., 18, 3688.

Decolorising Value of Weinreich's "Molass-char" and some Remarks on Technical Colorimetry.—By Washington Bureau of Standards Dec. 21, 1921. I. S. J., XXV. 46.

MOLASSES—CYANIDE.

The Manufacture of Sodium Cyanide from Distillery and Sugar House Residues.—De Jassien.—Industrie Chimique 9, 530—3 (1922). C. A., 17.

MOLASSES—DESACCHARIFICATION.

Deguide Process for the Desaccharification of Molasses (beet or cane).—By H. W. Dahlburg. Facts About Sugar 1924, 19, No. 7, 155—157. I. S. J., XXVI. 668.

Comparison of Results in Desugarization with the Steffen, Lime, Barium and Strontium

Processes.—By Mich Potoliet, J. Ind. Eng. Chem. 13, 102—4 (1921). C. A., 16, 171.

Barium Sulphate and the Desaccharification of Molasses.—Manoury, J. Fabr. Sucre. 63, No. 35 (1922). C. A., 17, 222.

The Commercial Applications of Electro-osmosis.—By J. H. Frydlender, Rev. Prod. Chem. 25, 721—30 (1922). C. A., 17, 496.

Use of Molasses in the Diffusion Battery.—By Josef Hamons. Listy Cuknovar 41, 213. (1922-3). C. A., 18, 1921.

Refining Sugar from Refuse Molasses.—By H. C. Cutler. U. S. 1, 493, 967, C. A., 18, 2084.

Improvements in Hot Saccharate Process.—By R. W. Shafor. Chem. Met. Eng. 31, 107—10 (1924). C. A., 18, 2973.

The Deguide Process in Desugarizing Molasses.—By E. Vrancken. Sucre. Bllge., 43, 2—18 (1924). C. A., 18, 3289.

Treatment of Molasses by the Vartya Process in Italy.—L. Lignesse. Bull. Assoc. Chim. Sucre., Dist. 41, 287-8 (1924). C. A., 18, 3487.

The Recovery of Sugar from Molasses.—By Z. Vytopil, Z. Zuckerind Czechoslovak Rep. 49, 15-16 (1924). C. A., 18, 3735.

The Extraction of Sugar from Molasses

by *Acetic Acid*.—J. de Gobert. La. Planter, 73, 308 (1924). C. A., 19, 412.

Sugar Recovery from Molasses by Acetic Acid by the Friedrich Rajtora Method.—By V. Rajtora. Z. Zuckerind Czechoslovak Rep. 49, 100—4 (1924). C. A., 19, 743.

Sulphate of Baryta and the De-sugaring of Molasses.—S. A. Experiment Station Library, E. L. G., 245.

Separating Sugar from Cane Molasses by Acetic Acid.—By V. Khainovsky. Java Archief. Vol. 33 (1925), 190—196. Sugar News XX, 1924, No. 24, 563.

Desaccharification of Cane Molasses.—By H. S. Pain, C. F. Walton, Junr., and V. Birekner. U. S. Patent 1, 572, 359, Feb. 9, 1926, Facts About Sugar XXI (1926), 378.

Recovery of Sucrose from Cane Sugar Molasses.—By E. R. Watson, K. C. Mukerjee, D. N. Gupta and H. S. Chaturvedi, Quart. J. Ind. Chem. Soc. 3, 229—44 (1926). C. A., 21, 666.

Desugarizing Molasses with Lime by the New Process of Carl Steffen, Jnr.—Dent. Zuckerind, 51, 1137-8 (1926). C. A., 21, 82.

MOLASSES—VARIOUS USES.

Discovery of the Presence of Vitamins in Cane Molasses.—By J. P. Ogilvie ; I. S. J., XXVII, 139.

Poisoned Molasses for the destruction of Noctind Moths.—By H. E. Strickland, J. Econ. Entomology 15, 214—20 (1922). C. A., 16, 3726.

Destructive Distillation of Molasses.—Syndicat. D'Etudes Chimiques, Brit., 208, 516, Oct. 25, 1923, C. A., 18, 1584.

Butyl Alcohol and Acetone by the Fermentation of Molasses.—By G. C. Robinson, U. S. 1, 510, 526, C. A., 19, 145.

Treating Crude Petroleum with Molasses.—By W. H. Kaul, U. S. 1, 523, 219. C. A., 19, 892.

Molasses as a Source of Vitamin.—By V. E. Nelson, V. G. Heller and E. J. Fulmer. Ind. Eng. Chem. 17, 199—201 (1925). C. A. 19. 1152.

Dried Molasses Product Containing Casien.—By S. D. Wilkins; U. S. 1, 548, 293.

Production of Acetone and Alcohol from Cane Molasses.—By J. H. Northrup, L. H. Ashe and P. R. Morgan. J. Ind. and Eng. Chem. 1919, 11 No. 8, 723—727. I. S. J.; XXII, 53.

The Gasification of Molasses Residues, and the Recovery of Potash, Sodium Cyanide and Ammonium Sulphate.—F. Muhlert. Chem. App. 12, 156—7, 189—91, 211—3 (1925) C. A.; 20, 307.

Production of Glycerine from Molasses.—Anon. I. S. J.; XXIX, 556.

BAGASSE—GENERAL.

Surplus Bagasse.—C. J. H., Penning ; I. S. J., 25, 185—191 (1923) C. A., 17, 2653.

Chemical Composition and Digestibility of Bagasse and Rice Straw. Hachiro Kumagawa and Ken Kichi Shiminura.—By Z. Angew. Chem. 36, 414—8 (1923) C. A.; 17, 3419.

Plant Products as Chemical Raw Materials.—By Wm. A. Taylor. Chem. Age (N. Y.) 31. 549—51 (1923) : C. A. 18, 871.

Preserving Bagasse.—By F. B. Munroe ; U. S. 1, 503, 202, July 29, C. A., 18, 2975.

Deterioration of Bagasse on Keeping.—
(1) A. Loos and A. Schweizer Archief Suikerind, 1919, 27, No. 37, 1772—1775.
(2) C. Tansen., *Ibid*, 1919, 37, No. 42, 1974-1975, I. S. J., XXII, 169.

Problem of the Disposal of Surplus Bagasse in the Phillipines.—R. Renton Hind ; Sugar News, 1921, 2, No. 6, 219—222, I. S. J., XXIII, 587.

Surplus Bagasse.—By C. J. H. Penning, I. S. J., XXV, 185—191.

The Australian Sugar Industry.—By R. D. Chataway, I. S. J., XXVII, 34.

BAGASSE—FUEL.

The Calorific Value of Bagasse.—By P. H. Parr ; I. S. J., 24, 13—18 (1922). C. A., 16, 2426.

Fifty per cent. Saving in Fuel.—By B. J. Van Santen, Arch. Suikerind, 29, 1193—5 (1921). C. A., 16, 354.

Formula for the Fuel Value of Bagasse.—Ph. Van Harreveld, Arch. Suikerind 30, 477-8 (1922).

The Gilchrist Bagasse Furnace.—Anon. I. S. J. 24, 257—60 (1922). C. A., 3381.

Baled Bagasse as Fuel for Locomotives.—By C. J. Schott. Arch. Suikerind 30, 858—65 (1922). C. A., 17, 1165.

Experience in Java with Mixtures of Bagasse and Trash as Fuel.—Anon. I. S. J., 25, 473 (1923). C. A., 17, 3771.

Utilization of Bagasse Fuel.—By Z. Kogam La Planter 70, 230-1 (1923). C. A., 17, 2182.

Utilization of Bagasse Fuel.—By Z. Kogam La Planter 70, 349 (1923). C. A., 17, 2793.

Furnace for Burning Bagasse and Liquid Fuels.—R. Almagro ; U. S. 1, 478, 418, C. A., 18, 747.

Burning Molasses Mixed with Bagasse.—Ph. Van Harreveled, Arch. Suikerind 32, 1095-6 (1924). C. A., 19, 415.

Dutch Ovens for Bagasse.—By J. O. Frazier—Power 60, 682-3 (1924). C. A., 19, 745.

Bagasse Furnaces.—A. G. Budge, I. C.S., XXII, 211. Boiler Tests carried out in Phillipine Islands using Bagasse as Fuel. By D. M. Semple, Sugar News, 1921, 2, No. 5, 159-161, I. S. J., XXIII, 698.

Bagasse Furnaces in Gur Factories.—By H. R. Stewart and Kharak Singh, Agr. Journ. of India 18, No. 6, 584—595.

Experiences with True Types of Bagasse Furnaces.—Power 1925, 60, No. 18, 682-683, I. S. J., XXVII, 161.

Tests made in South Africa with a "Turbine" Furnace for Bagasse.—Anon. Sth. Afric. Sug. J., 1926, 10, No. 3, 149—151.

Fuel Consumption in Different Countries in Cane Sugar Factories.—By G. J. Schott. Archief, 1926, 34, No. 12, 327-328, I. S. J., XXVIII, 442.

Bagasse as Fuel.—By R. F. Hutcheson, I. S. J., XXVIII, 652.

Possible Economies in Drying Bagasse.—By C. E. Burgoon, S. A. Experiment Station Library, E. L. G., 124—136.

Increasing Fuel Value of Bagasse.—By H. Sornay, S. A. Experiment Station Library, E. L. G., 581.

Wider Application of Bagasse Energy.—By J. O. Frazier, S. A. Experiment Station Library, E. L. G., 608.

Experimental Study of Bagasse and Bagasse Furnaces.—C. W. Kerr and E. M. Percy, S. A. Experiment Station Library, E. L. G. 985.

Bagasse Drying.—E. W. Kerr and H. A. Nadler; S. A. Experiment Station Library. E. L. G., 989.

The Use of Bagasse for Steam Generation.—E. W. Kerr and H. A. Nadler; S. A. Experiment Station Library. E. L. G., 1354.

Heat of Consumption of Bagasse from Hawaiian Cane.—R. S. Norris; S. A. Experiment Station Library, Pamp. 1360.

Secondary Combustion Chamber for Bagasse Furnaces.—T. W. Helmers. Java Archief. Vol. 33 (1925), 8—11. Facts About Sugar XX. (1925), 401.

Judging the Combustion of Bagasse by a Graphic Method.—By J. F. Voorwijk. Arch. Suikerind 34, 1—6 (1926). C. A., 20, 1917.

Fuel Consumption in Various Countries.—By G. J. Scott. Arch. Suikerind 34, 327—8 (1926). C. A., 20, 2425.

Fuel Value of Bagasse.—By M. Van de Kreke. Arch. Suikerind 35, 569—97 (1927). C. A., 21, 3283.

Bagasse Furnaces.—By G. H. W. Barnhardt ; I. S. J. XXIX. 603.

BAGASSE—MILL-BOARD PAPER AND FIBRE.

Production of Power Alcohol and Paper Pulp from Bagasse.—G. J. Fowler and Bhola-nath Bannerjee ; J. Indian Inst. Sci., 4, Part 15, 241—60, (1921). C. A., 16, 1504.

Fibre From Bagasse.—By D. E. Scott ; U. S. 1, 399, 891, C. A., 16, 839.

Insulating Timber from Sugar Mill Bagasse.—By A. G. Wikoff. Chem. Met. Eng. 29, 360—2, (1923). C. A., 17, 3593 ; I. S. J., XXV, 605.

Preserving Bagasse Fibres.—G. B. Munroe ; U. S. 1, 479, 419. C. A., 18, 752.

Paper Pulp from Bamboo, Bagasse and similar Materials.—By W. A. R. M. McRae, Brit. 213, 003, Dec. 22, 1922. C. A., 18, 2249.

Manufacture of Paper from Bagasse.—By C. W. Mason. Paper 34, No. 6, 240 (1924). C. A., 18, 2808.

Paper Making Fibre from Bagasse.—By J. K. Shaw ; U. S. 1, 503, 924. C. A., 18, 2963.

Apparatus for Continuous Cooking of Pulp-Making Fibres.—G. B. Munroe ; U. S. 1, 503, 549. Aug. 5. C. A., 18, 2963.

"Celotex" a Product from Bagasse.—J. Van Harre-veld. Arch. Suikerind 32, 537—41 (1924). C. A., 19, 189.

Paper Making Qualities of Bagasse from Hawaiian Mills.—A. D. Little; H. S. P. A., S. A. Experiment Station. Bull No. 46. I. S. J., XXII. 112, XXII. 453.

Examination (Chemical and Microscopical) of Bagasse from the point of view of Paper Making.—La Papeterie, 1920, 42, 539—542, 578—587, I. S. J., XXIII. 53.

Utilization of Bagasse for the Manufacture of Mill Board (Celotex) in Louisiana.—By R. Renton Hind. Sugar News; 1922, 3, No. 2164—72.

Book and Writing Paper Produced from Bagasse.—Planter and Sugar Manufacturer LXXVIII, Page 221. No. 12.

"Celotex" and the man behind it.—R. Renton Hind. Sugar News, Vol. 7, No. 1, 7.

Fibre-board from Bagasse.—By G. G. Munroe; U. S. 1, 574, 254. C. A.; 20, 1523.

Substitute for Lumber from Bagasse.—By J. K. Shaw; U. S. 1, 572, 565, C. A., 20, 1310.

Pulp from Bagasse and similar Material.—E. C. Lathrop and G. B. Munroe; U. S. 1, 572, 539, C. A., 20. 1323.

Wood Substitute.—1. Naylor; U. S. 1., 573, 734. C. A.; 20, 1508.

anufacture of Bagasse Board.—C. W. Mason; U. S. P. 1, 627, 103. B. C. A. B.; 1927, 473.

BAGASSE—VARIOUS USES.

Production of Power Alcohol and Paper from Bagasse.—By G. J. Fowler and Bhola-nath Bannerjee; J. Indian Inst., of Sci. 4, part 15, 291—60 (1921). C. A.; 16, 1504.

Preparation and Evaluation of a Decolorising Char from Bagasse.—By C. E. Coates; J. Ind. Eng. Chem. 14, 295—8 (1922). C. A. 16, 1675.

A New Source of Fertilizer.—By K. Adinaryan Rao; Agr. J. of India, 17, 476—82 (1922). C. A., 17, 1524.

Use of Sugar Cane Residue as a Fertilizer.—By W. Nathan-Levy Bull. Assoc. Chim. Sucr. Dist. 41, 207—10 (1924). C. A., 18, 3123.

Generating Gas from Bagasse.—By B. J. van Santen. Arch. Suikerind 32, 1365—9 (1924). C. A., 19, 885.

Feeding Bagasse.—By C. H. O' Rourke; La Planter 74. 148—9 (1925).

Preparation of Bagasse Carbon.—By C. E. Coates. New York Meeting Sugar Section of American Chemical Society. I. S. J., XXIII, 625.

Utilization of Straw (and possibly of

Bagasse) for Production of Farmyard Manure.—By H. B. Hutchinson and E. H. Richards. J. Minist. Agric, 1921, 398. I. S. J., XXIV, 45.

Recent Work on Decolorising Carbons.—Anon. I. S. J., XXIV. 473—480.

Experiments on the Production of Power Alcohol and Paper Pulp from Bagasse.—By G. H. Fowler and B. Bannerjee ; J. Indian Inst. Sci ; Vol. 4, Part 15, 241—260 (1921). I. S. J., XXIV, 661.

Fermentation of Bagasse in Relation to the Yield of Industrial Alcohol.—By W. L. Owen and N. Bennet ; I. S. J., XXVIII, 463.

Fertilizer.—By R. R. Hind; U. S. 1, 583, 151, C. A., 20, 2043.

Burning Limestone by Means of Generator Gas from Bagasse.—C. A. Van Haeften. Arch. Suikerind 34, 463—3 (1926). C. A., 20, 2918.

FILTER PRESS CAKE—GENERAL.

Analysis of Hawaiian Filter Press Cake. S. S. Peck. Sugar News 3, 66 (1922). C. A., 17, 2794.

Composition of Filter Press (Lime) Cake.—By S. F. Sherwood ; U. S. Dept. Agr. Circ., 257, 1—3 (1923). C. A., 17, 2467.

Nitrification of Press Cake in Acid Red Clay Soils of Porto Rico.—By J. H. Ramirez;

La Planter 70, 48—50 (1923). C. A., 17, 1103.

Purification Process and Equipment for the Extraction of Sugar from the Scum in the Manufacture of Sugar.—By Askan Muller. Z. Zuckerind Czechoslovak Rep. 46, 585. Chem. Zentr; 1923, 11, 37, C. A., 17, 3425.

Sugar From Sugar Cane Mud.—By E. Delafond; U. S. 1, 476, 152. C. A., 18, 1357.

The Value of Cachaza as a Fertilizer.—By H. Ramirez; Porto Rico Dept., Agr. Labor. Sta. Bull. 31 (Spanish Ed.), 5—32 (1922). S. A. Experiment Station Record. 49, 23. C. A., 18, 1357.

FILTER PRESS CAKE—CANE WAX.

Cane and Berry Wax.—By M. Rindi; S. African J. of Ind. 5, 513—8 (1922). C. A., 17, 646.

Sugar Cane Wax.—By L. de, Sornay. Rev. Agr. Maurice 1, 77—8 (1922). C. A., 16, 3008.

Constituents of Cane Wax.—By J. E. Quintus Bosy. Archief Suikerind 28, No. 25, 974—977 (1920). I. S. J., 23, 53.

Wax from Sugar Cane.—By C. Ludecke. Seifensieder Ztg. 53, 316—7 (1926). C. A., 20, 3356.

Extraction of Wax from Filter Cake or Residue of Cane Sugar Manufacture.—By G. McKenna. B. C. A. B., 1927, 665.

CANE TOPS AND TRASH.

Preparation of Decolorising Carbons and use of Cane Trash as a Filtering Medium.—

By C. E. Coates. Facts About Sugar 15, 257 (1922). C. A., 17, 2970.

Experience in Java with Mixtures of Bagasse and Trash as Fuel.—Anon. I. S. J., 25, 473 (1923). C. A., 17, 3771.

Plant Products as Chemical Raw Materials.—By W. A. Taylor. Chem. Age (N. Y.) 31, 549—51 (1923). C. A. 18, 871.

Cane Trash as a Source of Humus.—By A. C. Pestana. Bol. Min. Agr. Ind. E. Econ; Brazil. Vol. 14 (1925). 485—487. Facts About Sugar XX (1925), No. 31, page 736.

PART II.

Cane Cultivation in India.

CHAPTER VIII.

METHOD OF TRENCH CULTIVATION.

The best and the most certain results with improved varieties of canes, both as regard germination and yield per acre, are obtained by sowing in shallow trenches.

The total cost of making the trenches and preparing them for sowing the cane is approximately Rs. 15 per acre.

The detailed expenditure is as follows :
In a field 60 yds. wide, containing 60 trenches for acre, three men at a daily wage of annas 4 can make 4 trenches a day, the cost working out at Rs. 11-4-0 per acre. After the trenches are made they have to be dug at once to a depth of nine inches, one man can dig four trenches 60 yds. long in a day. This works out at Rs. 3-12-0. The total cost being Rs. 15.

It should be remembered that so much depends on the thorough preparation of the

trenches and their preliminary cultivation before the cane is sown, that it is false economy to save a few rupees per acre by preparing the trenches indifferently. A crop of improved sugar will yield normally produce worth Rs. 400 to Rs. 450 per acre, and the amount spent on the preparation of the trenches cannot be considered an excessive outlay.

The method of trench cultivation is that medium canes are sown in trenches 2 feet wide and 4 feet from centre to centre. The preliminary preparation of the land for sugarcane is based on the method commonly in use among the cultivators (especially of Rohilkhand). There it is the universal custom to sow sugarcane on "porach zamin" or land that has remained fallow since the preceding rabi and which has been cultivated during the rains and following autumn. As many as forty ploughings with the desi plough have been known to be given by the best cultivators.

It is no doubt due to the stimulation which this system gives to the recuperative agencies at work in the soil (*Azotobacter* and other organisms) that desi cane has been able to be grown for centuries without manure. Small yields, as has been pointed

out, are the rule, but the yield does not appear to have undergone any diminution. It is about the same figure at the present time as that given in the "Ain-i-Akbari".

The method of trench cultivation is as follows. After the removal of rabi crop the land is ploughed with a turnwrest plow if cheap irrigation is available. In Rohilkhand, where canal irrigation is not available, the natural moisture, after a season of normal winter rainfall, is usually sufficient, if the land is ploughed quickly after the removal of the rabi crop. In most seasons the occasional showers of, from 0·5 to 1·0 inches, that occur in April, in May, enable ploughing of the rabi land to be carried out before the hot weather sets in.

The land is left open during the hot weather. In the rains the land is ploughed with improved iron ploughs and desi ploughs as opportunity offers and weather permits. It is not possible to say when this shall be done but it is important that no opportunity should be missed. The amount of cultivation possible during the rains is probably one of the chief factors determining the following crop.

The trenches are made between the middle of October and the end of Novem-

ber. The most convenient time to commence this is immediately after the work connected with the rabi sowings is finished.

It is most important not to delay the making of the trenches beyond November. It must be remembered that the land is being opened up to a greater depth than with ordinary cultivation, and the newly exposed soil requires a certain amount of weathering, if a good tilth and seed bed is to be obtained.

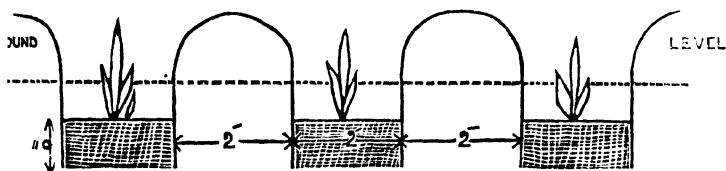
Unless trenches can be made at this time, it is not advisable to attempt this method of cultivation. It is no use starting to make trenches three weeks or a fortnight before sowing. This always leads to failure and disappointment.

For some years trenches of different sizes were used at Shahjahanpur, *viz.*, 2 feet wide and 4 feet from centre to centre for the thickest cane such as Ashy Mauritius and M. 16, and trenches 18 inches wide and 3 feet from centre to centre for the medium canes such as the Java and Natal canes.

As a result of several years' experience it has now been decided that trenches 2 feet wide and 4 feet from centre to centre are most suitable for both thick and medium canes, if the land is in good condi-

tion and sufficiently manured. This size has been adopted at (*Shahjabanpur*).

The sketch in the accompanying figure illustrates the arrangement. The trenches are 4 feet from centre to centre, and each trench is 2 feet wide and separated by a space of 2 feet from the next trench. The soil from each trench is removed to a depth of 6 inches and placed on the two feet space left between each two trenches, the whole making a series of ridges. The rows of cane are 4 feet apart.



As soon as the trenches are made, they should be dug with kasis to a further depth of nine inches, and the dung, city refuse, oil cake, or whatever manure is available, should be applied. The manure

should be strongly mixed with the soil and allowed to remain with occasional digging, if this can be arranged for.

It should be remembered that the more thorough the cultivation of the recently opened up soil at the bottom of the trenches the better will be the result.

To obtain a good crop of improved sugarcanes by this method of cultivation, manure containing 120 to 150 lbs. of nitrogen per acre is required. Local conditions will largely determine the cheapest form in which this can be obtained. In the United Provinces, where an extensive oil pressing industry is developing, the various forms of oil cake meal furnish an excellent source of nitrogen, which is very quickly available for plant food owing to the rapidity with which the bacterial action necessary to render it so, takes place in the soil of semi-tropical countries, Castor cake meal is obtainable in moderate quantity in the United Provinces. It contains approximately $4\frac{1}{2}$ per cent. of Nitrogen, 5 mds. contain 18 lbs. of nitrogen, 35 mds. per acre will be equivalent to 126 lbs. of nitrogen per acre. 40 mds. per acre will be equivalent to 144 lbs. of nitrogen per acre.

The price varies from year to year and is usually between Re. 1-8 to Re. 1-12-0 per maund for *Shahjahanpur*. The outlay on manure is the heaviest cost the grower of improved sugarcane will have to meet. A handsome return is always obtained at *Shahjahanpur* for money expended on manure—both from the crop of sugarcane, and the following crop of wheat.

The question of keeping down the cost of manure is an important one, and is under consideration, but it is not likely that it will be possible to reduce it to any great extent. The development of the oil pressing industry in India is one of the few things that would do so. Any steps that could be taken to extend the working up of oil seeds in the country would be immeasurable both to agriculture and to cane growing especially.

Any kind of oil cake can be used, but it should be remembered that all do not contain the same amount of nitrogen. In working out the amount of the meal to apply per acre the nitrogen content must be taken into consideration.

It was formerly the practice at the research station to apply the oil cake, meal in two doses, one before sowing and one

just before the canes were earthed up. There appears to be no advantage in this, and the whole of the manure is applied very soon after the trenches are made.

It may be pointed out again that the effect of liberally manuring the cane is not confined to that crop alone. The residual nitrogen, and the deep cultivation of trenches, enables a humper crop of wheat to be grown. Yields of 35 mds. per acre of Pusa 12 have been obtained for several years. In the harvest of the 1919 rabi crop 36½ mds. of Pusa 12 per acre were obtained over a field of 3½ acres with one irrigation of 4 inches in November. The preceding crop was Mauritius sugarcane, which yielded 948 mds. per acre (34·7 tons).

Canes are sown in trenches from the end of February to the first week in March according to the season. It is useless sowing the canes before the soil is warm enough for the vigorous growth of the buds and young shoots.

At least a month before sowing the trenches are irrigated (4 to 5 inches of water, if the winter rains have not provided sufficient moisture. When the land is dry enough the seed bed is prepared by digging the trenches with kasis and the cane is sown.

For this purpose, round canes are selected, but cut into small pieces or sets, each set containing at least three healthy beds. The sets are planted in the bottom of trenches in a small ridge 4 inches deep and carefully covered up with earth.

The method of planting is as follows :— Six men in the background are making the small ridges with kasis in the bottom of the trenches. Five men in the foreground are planting the sets in the small ridges at a distance of nine inches apart.

After planting, the trenches are carefully hoed and canes left to germinate. About 6,000 – 8,000 sets are required per acre when the trenches are four feet from centre to centre. For thick canes, such as Ashy Mauritius and M. 16, 60 mds. of Trimmed cane per acre are required and for medium canes 40 mds.

After sowing and before the young shoots appear, the canes are hoed three times. This is not a difficult operation with kasis, the universal tool for cane cultivation in Rohilkhand. Care must be taken to see that the men working at the side of the trenches, do not injure the young growing shoots which have not yet appeared above ground.

Hoeing with kasis is the common practice in Rohilkhand and is an excellent one. It helps to keep the moisture in the soil, to aerate the later, and to promote the proper decomposition of organic matter. It is infinitely superior to the superficial weeding that is often given with kurpies.

This is the time when *white-ants* give trouble, if it is a district where they are prevalent. Frequent cultivation helps to keep them within limits, but there is no cure for them and as a last resort, if the attack is bad, irrigation must be resorted to.

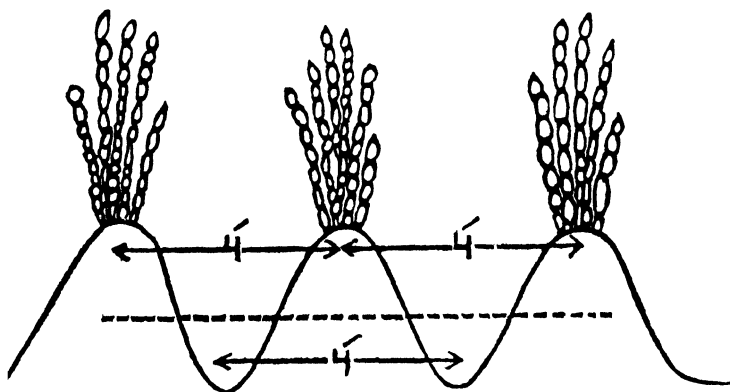
In the normal course of events, where white-ants are particularly troublesome, a second irrigation will be required when the canes have germinated and are six inches above the ground about 5-6 weeks after sowing.

As soon as the young canes have begun to grow and tiller vigorously, when the young plants are about 2 feet high, the trenches are gradually filled in. It is advisable to do this gradually, beginning about the middle of May and completing the operation by the end of the month.

Before the rains begin the earthing pu

of the canes should be commenced. This operation serves to keep the canes standing during the monsoon and the quality of rab and gur depends entirely on the thoroughness with which this operation is carried out.

The importance of keeping the cane standing by earthing up cannot be over-estimated. Heavy crops of cane nearly always fall down during the monsoons if this is not done. The quantity and particularly the quality of the rab and gur is badly affected. It is impossible to get the light coloured danedar rab and gur so much prized in the bazzars from a crop of fallen cane. When the earthing up is finished the field presents the appearance shown in the following diagram.



During a normal monsoon, if the earthing up has been well done, very little attention is required, except that it is desirable to keep down the weeds by cultivating between the rows whether permits, if the rain fails or is short this cultivation between the rows of canes is most essential.

If the monsoon is very poor, an additional irrigation may be required in October, after which nothing more is needed until the harvest in the following January, February, March.

The method of trenching described above requires a certain amount of capital and irrigation facilities. It is suitable for those places in sugarcane districts, where wells, tube wells, and pumping plant have been successfully installed. Indeed at the present time a better method of getting a speedy return from the latter improvements cannot be easily found than the intensive cultivation of improved varieties of sugarcane for gur and rab manufacture.

The introduction of the cultivation of improved canes by intensive methods is an entirely different problem from the introduction of improved varieties of such crops, as wheat, gram and cotton, which show some beneficial result with little or no

alteration in the existing methods of cultivation, and allow the potentialities of the new variety with regard to yield to be worked up to gradually by improved farming.

Such a coarse is not possible with new sugarcanes, the change must be immediate, from the poor yields of the indigenous varieties to nearly three times as much obtained by growing selected canes under intensive conditions.

It is not likely that a cane will be found, giving the largely increased yield over desi varieties given by thick and medium selected canes, which can be distributed to cultivators, without instruction and demonstration in better methods of cultivation.

Progress in the case of improved cane cultivation will be slower and more difficult than the introduction of a new wheat, for example which is soon measured in lakhs of acres.

The introduction of improved methods of cane cultivation will be accompanied by a general rise in the standard of agricultural practice throughout the provinces and materially increase the yield of other crops. Where the preliminary difficulties of initiat-

ing such a fundamental change have been overcome, improved methods of growing canes will be a most suitable and desirable method of demonstrating the advantages of better farming.

Example—

(1) Ashy Mauritius cane :—

Yield was 948 mds. per acre (34.7 tons).

Sucrose % Cane = 13.4

Sucrose % Juice = 16.2

Purity of Juice = 87.2.

(2) Medium Cane :—

Yield = 1055 mds. per acre (38.6 tons.)

Note.—The above notes are applicable only to new varieties of cane introduced in India.

IMPROVED CULTIVATION OF DESI CANES.

For the cultivation of the pure races of the desi canes of Rohilkhand :—

After the removal of the rabi crop the land is prepared for sugarcane in the manner described in the preceding section. It is ploughed, and left open during the hot weather, and cultivated during the rains and following autumn. It is ploughed three times with a turnwrest plough and about 12 times with the desi plough. This is not a hard and a fast rule and can be slightly varied as circumstances suggest.

Desi canes will not stand much of manure and our experience at *Shahjahanpur* is that the quality of the juice begins to deteriorate if more than 10 mds. per acre of castor cake is applied, to the varieties commonly grown in Rohilkhand. Any manure that is applied should be sown broadcast about six weeks before sowing and thoroughly mixed with the soil by ploughing.

As there is no deep cultivation by digging as in the case of trenching, every effort should be made to secure a deep tilth by ploughing with turnwrest ploughs. In Rohilkhand the area under desi canes depends upon entirely on the winter rains, if these are good the sowings are large. If winter rains fail desi cane must be sown on irrigation.

When the land is ready for sowing, after ploughing and levelling with the patila or wooden beam, straight lines are made in the field, 24 inches apart. This simple operation is easily done by a man and two boys provided with a piece of string and two bamboo sticks cut 24 inches long. This has the greatest advantage of enabling the men at sowing time to plant the cane sets in

straight lines. It cost practically nothing and greatly facilitates cultivation operations.

After sowing the canes are frequently hoed with kasis. When the crop is established the cultivation is the same as that given by the cultivators in the Rohilkhand. Irrigation is not always required, and not more than one irrigation is ever given at *Shah-jahanpur* to desi canes.

The result of the better preparation of the land and the small amount of manure, gives a small increase of cane and gur per acre, which if extended over a large area would mean a considerable addition of gur. Nothing in the nature of the striking results, recorded in the previous sections with selected and intensive methods should be expected and the following wheat crop is not much above normal. The following table gives results obtained at *Shahjahanpur* in 1918-19 with three pure races of canes selected from the indigeneous mixtures grown in Rohilkhand. As the land was in good condition no manure was applied.

No of Cane.	Yield of Cane per acre.		Cane Sugar per 100 Cane.	Purity of Juice.
	Mds.	Tons.		
A40	438	16'0	11'69	83'8
A39	474	17'3	12'47	87'5
A42	378	13'8	13'52	91'7

CULTIVATION OF MEDIUM CANE WITHOUT TRENCHES.

Some medium cane such as S39, S48, S50, have been grown without trenches at *Shahjahanpur* with some success, on fallow land that has been well cultivated and manured with 20—25 mds. of castor cake-meal.

The preparation of the land is the same as that described in the preceding section for the improved cultivation of desi canes. The manure should be applied, soon after the rains and sown broadcast. The land should be ploughed with iron ploughs as deeply as possible.

At the time of sowing lines are made as described for desi canes, but in the case of medium canes, these should be four feet apart.

The canes are sown with kasis in the ordinary way and frequently hoed before and after germination and after irrigation.

Before the rains the canes are earthed up in the same way as those grown in trenches. Thereafter the cultivation is the same as trenches.

The results are not so certain as when improved medium canes are grown in trenches, and the economical use of irrigation water is not so easy. The succeeding rabi crop is much inferior to that following cane in trenches. Quite good crops of cane have however been obtained by this method in good years, and unless the trenches are made in October or early November, and thoroughly well prepared, it is better to sow medium canes on the flat than in trenches badly prepared one or two weeks before sowing time.

CHAPTER IX.

"CANE DISEASES."

The study of plant disease is purely a scientific concern. Yet a brief description of the nature and progress of these diseases is necessary in order to grasp thoroughly the practical methods of fighting for them.

Diseases may be caused by:—

1. Unfavourable circumstances, *e.g.*, foot root, habit root.

2. Animals, *i. e.*, birds, worms, etc.

3. By the lower plants.

- (a) Bacteria, *e.g.*, gumming disease, sereh,

- (b) Moulds (fungi) *e.g.*, red rot, pine-apple disease.

Diseases are distinguished as follows:—

1. Diseases of the stem.

- (a) Red rot.

- (b) Pine-apple disease.

- (c) Dongkellan disease.

- (d) Bibit rot.

- (e) Gumming disease.

- (f) Sereh.

2. Diseases of the sheath—

- (a) Eye spot disease.
- (b) Red rot.

3. Disease of the leaf—

- (a) Djamor. Oepas.
- (b) Yellow spot disease.
- (c) Rust.
- (d) Ring spot disease.
- (e) Eye spot disease.
- (f) Yellow stripe disease.

4. Disease of the root—

- (a) *Root Rot.*

1. (a) *Red Rot.* No outward signs are visible in the cane, but in the longitudinal section of the stem, this disease is clearly visible. Its typical characteristic is light coloured spots in the horizontal direction through the internodes surrounded by a bright red colouration increasing intensity towards the edge and ceasing abruptly. An acid smell is also generally noticeable. Occasionally the inter-nodes have black fibro-vascular bundles, in that case the same disease is already far advanced. At the same time cavities are visible in the stem. The mycelium grows chiefly in the pith in the middle of the joint. In this many fungoid filaments occur, where-

as in the red part few of such of filaments are present. These seem to secrete toxee substances. The parasite penetrates into the dead cells by means of its Hyphae and uses up the red coloring matter, so that these turn white. The fibro-vascular bundles are unaffected, so that the absorption of food may continue without interruption. The round old joints are not affected, as in these the epidermal cells have as yet no thick walls. The older joints may indeed be infected, but only through holes and wounds; holes made by borers, cracks or wounds caused by boring aff leaves, etc., Red rot is therefore only caused by wound parasite. Red rot does not cause serious injuries in Java, such damage is indeed occasioned, when the hituts (or sits) are taken from diseased stem. As no outward signs are visible on the stem, one is never sure, even though the stem is sound, that one is taking a healthy hibit.

Red rot is pre-eminently a disease of spongy cane. If, therefore, many complaints are heard about the prevalence of red rot, here generally is something wrong with the cultivation of cane.

1. (b) *Ananas or Pine-apple disease*.— This is chiefly a *disease of the hibit*, especial-

ly of cane reed and not of full grown plant. The set first turns red inside and after that deep black. This black occurs as a "pipe". Through the axis of the cutting being central, while the black of the red rot is rather marginal and seldom symmetrically arranged. The diseased parts emit a strong odour of pine-apple, which serves as a typical characteristic. The difficulty in diagnosing the disease is the same as in the case of red rot, for it is only found in the inside of the stem and is not visible, on the outside. The red colour is caused by the death of the cells; the fibro vascular bundles, however, also grow red, which points to gumming.

The disease is of very general occurrence and is found in all the sugary fruits such as havana mango, etc. The eyes of the hibits effected by the pine-apple disease do not sprout. As in the case of red rot, the set is only infected if there is wound. *We have to fight the disease by prevention and it is therefore necessary to disinfect the hibit with tar in the ends directly after cutting as the entrance of the disease is at the ends of the hibit.* Disinfection with Bordeaux mixture is insufficient according to Ardeusen Hein.

1. (c) *Dongkellan Disease*.—If the Dongkellan, *i. e.*, the part of the cane that is hidden underground is diseased, the stem may be easily pulled out of the ground by hand, as the roots have died. The leaves have withered and a longitudinal section reveals that the root possesses the ordinary size of sponginess, while the Dongkellan is quite dead. In it red spots or cavities are usually found, surrounded by a red border which contains fungoid threads.

The probable cause is the choking of the roots in a closed up soil and drying up climatic circumstances. As the cane is merely full grown before the disease is perceptible, there is no other means to combat it than by growing an early crop, since the cane is very spongy and further ripening is impossible; on the contrary, the juice instead of improving deteriorates greatly.

(d) *Bibit Rot*.—This disease manifests itself at early age, when the young plants have not got their own roots and so live on Bibit and what bibit takes from soil by its roots. The white tissue of the bibit becomes darkish, dark brown owing to the biological conversion of cellular contents. This is caused by putrefication usually due

to excess of moisture in the soil. The consequence is that, roots cannot develop, bundle are seriously affected, leaves shrivel and the young plants have languishing appearance. Such plants should be removed, soil turned up and new plants should be planted. The soil should have proper moisture.

1. (e) *Gumming disease*—Cobb of Australia says that it is due to a bacterium—*Bacillus Vascularum*—In cold climate the cane is very sensitive to this disease but it is less virulent in the warmer regions.

Probably this disease is an effect rather than a cause, it occurs only secondarily when circumstances are bad. In older plants it may give rise to double mischief; for if there is an excess of water the roots rot, if too little they dry up; and in either case Bacteria appear, with the result that the plants which were already in bad condition because of too much or too little water, are still worse off. In such case mother stem begins to wither and the plant tillers excessively in consequence and dies suddenly. So the cane dies in either case. In still older cane, however, the progress of the disease is less acute and may often

be arrested. Generally many eyes put forth and the growing point rot.

The symptoms of the disease in young plants of one and a half to three months old are these :—

1. The Bacterum penetrates through the fibro-vascular bundles of the stem into the leaves and cause a long, usually sharply outlined stripe on the newly uncurled leaf. This runs from the mid-rib to the edge of the leaf as a rule. It may be continued down the sheath and along the stem: the colour is first white and afterwards dull brown. In the end the stripe dries out. Sometimes the leaves become white mottled.

2. In badly affected plants, the young leaves get jammed in between the sheaths of the older leaves, which do not unfold in time, because of which a sort of "Pokkah Bong" is formed which sometimes breaks out, but in most cases is only visible in cutting the top longitudinally.

3. If the affected stalk is cut longitudinally, it appears that the fibro-vascular are red coloured throughout from the base nearly up to the growing point. In the case of the Sereh disease, the discoloration

is most marked in the lower joints, greatly decreasing upwards. In the case of the gumming disease, gum is also found in the internods, but in "Sereh" only as a rule, in the nodes.

4. Sections of the growing point are orange coloured, the colour is carmine in varieties, whose growing point is naturally orange.

5. The root system is badly developed and an abnormal number of seekers appear.

6. In the pith parinchyma close under the growing point, unfittated, greasy, brown spots occur which occasionally change into cavities with brownish black edges.

The disease is sporadic, *i. e.*, the diseased plants are found here and there among the healthy ones and not in groups.

The symptoms in crushing causes are:—

1. Red colour of fibro-vascular Bundle, the intensity of which diminishes from the top towards the underground part; this is the reverse of what is observed in "Sereh."

2. Many eyes put forth leaves and then die. If the symptoms enumerated are insufficient to decide whether the cane is attacked by the gumming disease, only a

pure culture by nursis of the so-called accumulative method can give a decisive answer.

The disease may crop in young seedlings, which is proof positive that the Bacteria do not penetrate through the bibit but through the roots.

Wakkar surmises that top rot and pokka *plus* Bong are connected with the gumming disease. Grounewege considers the *Basilus Vascularum* (cobb) as the cause. According to him the disease only occurs after Bibit has set in, enabling bacteria to penetrate. The gumming disease is therefore supposed to be secondary.

Disinfection is of no avail in the case of the gumming disease. In the 1st stage the affected plants may be removed and burned outside the field, but this will soon prove impracticable, the only remedies are water and earthing up, because of which a new system may be developed. If it is very virulent, it may be advisable to fill the gaps with cutting from varieties that are less liable to be attacked. One chief care, however, should be to prevent the disease only :—

1. Refusing bibit from the fields infected with gumming disease, for diseased

bibit is likely to grow into diseased plant.

2. Cultivating susceptible cane varieties as little as possible and not in any case cultivating them in fields that have produced cane affected by gumming disease.

3. Not cultivating such varieties in fields where drainage and physical conditions of the soil favour the disease.

All varieties are not equally susceptible to gumming disease, though, so far, not a single has proved immune.

1. (f) *Sereh Disease*.—*Sereh* disease may occur in various degrees of virulence. A slighter form is also *Scene tibou Disesse*, as the gumming takes place in the sieve tubes. It may be known by the red colour of these tubes, it is first visible in the very lowest parts of the stem, and is indeed most virulent in that part and then it spreads slowly decreasing. In the initial stage, the red colour is only visible in the fibro-vascular bundles of the nodes, and the cane has a healthy appearance, but when the disease gets worse the red fibro-vascular bundles are visible throughout the stem. The disease passes into the *Sereh* stage in which the whole plant presents a distinctly languishing appearance. The fibro-vascular

bundles are so tightly choked up by the gum that the plant can hardly inhale and water. The majority of the schools, remain short and stunted, the roots in the soil are badly developed and those of the stem grow out in abundance, so that a sort of felt made up roots is formed round about the stain while many eyes usually sprunt and put forth shoots. The plant generally dies early and yields no mature cane.

This disease was *first* noticed by Chirebon in 1882. After that it rapidly spread in Java and caused a tremendous damage.

This disease appears to be caused by the *Bacterum Lerbueolr Vascularum*. It can be prevented by selecting bibit from the undiseased crop and keeping the bibit in the mountain (cold climate) for some time. Another means to conduct by crossing it with some improved variety.

2. (a) *Eye Spot Disease*.—Eye spot disease occurs nearly in all varieties, cultured in large scale, and especially after the rainy season. On the leaf sheath clearly marked brick-red spots appear which shade the surrounding pale colour. In the centre of such spots is more or less a circular marking of a black brown colour. This disease causes little mischief in the cane

and may be contiated if required by removing and affected leaves.

2. (b) *Red rot of the sheath*.—Cane leaves affected with red rot show irregular group of brick-red spots on the leaf sheaths, which shade the surrounding normal colour. When the rains set in, white pertuberances arise on the surface; these are emerging Hyphae tissue. The filaments are closely interwoven. Very little else is known about this disease for as yet no means be confounded with the red-eye spot disease of the centre. This disease occurs especially in the leaf sheaths close above the ground and in young plantation; in particular in nurseries, because of excessive moisture. In case of virulent attacks, the stems are also affected and the infection spreads over the epidermis, in which holes are formed, while the eyes killed. Diseased stem should not be used for planting material. The disease is hard to combat. It is chiefly done by selecting unaffected bibits and by disinfecting the others with Bordeaux mixture.

3. (a) *Djamour Oepas*.—In plants affected with this disease, the leaves are marked with conspicuous liver-coloured spots with irregular outline and surrounded by a red-

dish-brown border. They are usually present in great numbers, occupying half the breadth of a leaf. It is probably an infectious disease, so that consecutive leaves are usually affected, and also the plants affecting the *first* affected plant. The disease does not do much damage and may be fought by removing and burning affected leaves.

3. (b) *Yellow Spot Disease*.—In plants affected with yellow spot disease, we find as the name indicates pale-yellow spots on the leaves, which soon turn bright yellow and show red dots and stripes later on. These spots have a irregular outline and frequently occur in such numbers as to run into each other. The damage done is slight and the disease is hardly ever cumbated.

3. (c) *Rust*.—In this case also the symptoms are implied in the name. At first orange-coloured and later brown longitudinal stripes appear, evidently emerging from the leaf. If we touch the under-side (for the disease is visible from either side), an orange, coloured powder adheres to the fingers. This symptom is characteristic of leaf rust and the disease is easily known by it. This disease also causes little damage

and can if necessary be combated by removing and burning the leaves.

3. (d) *Ring Spot Disease*.—Chiefly on the under side, irregular mostly oval-shaped spots arise of a dark green colour. In the middle a brown coloured centre develops which gradually spreads. The damage is slight and it is unnecessary to combat the disease.

3. (e) *Eye Spot Disease*.—In the initial stage, delicate red or reddish brown specks appear on the upper surface of the leaf which gradually lengthens into stripes. Round about them a yellow colour is noticed, shading into the green colour of the leaf. The outline oval and the longitudinal axis coincides with the direction of red stripe. The number of spots is very large as a rule. The damage is slight and the disease is surely combated.

3. (f) *Yellow Stripe or Mosaic Disease*.—This causes more damage, being cumulative, that is, it becomes more and more virulent if bits of diseased plants are used as planting material.

The leaves show yellow or pale green stripes, always terminating in a point and never reaching the whole length of the leaf.

They may be so numerous that several run into each other so as to form blotches. These stripes may be best observed in young leaves, when we stand with our backs to the sun.

In certain varieties stripes are continued lengthwise along the stem, they are dark, sometimes pale-coloured and shade into the colour of the leaf. But they never run on part the zone of the growth or the root zone, like the stripes of the phenomenon called *mottling*.

Little is known about the cause of this disease. Recent research suggests the possibility of micro-organisms as the cause as it has proved possible to infect healthy plants with the cellular liquid of diseased ones. In full grown cane the yellow stripe disease causes hardly any mischief, but the damage is all the greater, if the bolls are always taken from the diseased crop. Especially in mountain districts it may bring about failure of crops, whereas in the plains some varieties as No. Po, 213 do not apparently suffer any harm but yield a fairly good return.

The degree of virulence is largely influenced by atmospheric conditions. Especially in rainy season, when the sky is

clouded, it may break out violently and so it is especially the nurseries that suffer. When much rain falls and the sky is clouded, especially in the 2nd month after planting, the disease is very virulent. On the Sampal Wasak Sugar Estate, situated in the mountains, author found 58% of the diseased plants, whereas in the sunny weather and little rain, only 7.4% were diseased. The only remedy is discarding diseased plants as propagation material. It does not suffice to avoid bibits from diseased stem where leaves show yellow stripes, but cutting must not be taken from healthy stems of the same plant as the disease in habit in them. At least it has been proved that in a plantation formed of such stems, striped disease breaks out sooner than in plantations formed of stems of perfectly healthy plants. The disease may be so violent in nurseries that the bibits cannot be used for propagation. It frequently happens that there are 80 per cent. or more of diseased plants in plantation.

4. *Root Rot*.—Root rot is confined to the soil and is not infectuous. The roots are badly developed, attaining only to one-third of their normal length and therefore commanding a considerably smaller part of

the soil. Such cane must necessarily soon suffer from draught. More water should then be supplied, which in heavy soil causes a less favourable construction. Root rot is therefore found in heavy clays. Moreover the water supply of a plant afflicted with root rot is inadequate. Through the putrifying roots all sorts of organisms penetrates with facility, to which the plant responds by choking the higher vascular bundles especially of the under-ground parts with gum.

The disease may be prevented by rational cultivation of the soil and by keeping it in good condition.

INDEX.

A

	PAGE
Alcohol	5
Anti-knocking Property	12
Avoiding of the formation of Carbon	12
Making the explosion less sudden	13
Starting qualities	13
Ash Product of Molasses	
Analysis	35
Composition	36
Ashy Mauritius Cane	78

B

Bagasse :—	
General	56
Burning	57
Furnaces	58
Mill Board Paper	59

C

Cane Diseases	
Causes	83
Symptoms	83
Cattle Food	56
Cheap Confectionery	5
Country Spirit	6
Calorific Value of Molasses	30
Conversion of Molasses into Ash	30
Compound Fertilizer	38
Cane Cultivation	65
Method of Trench Cultivation	65
Thorough Preparation of land	66

D**Disposal of Molasses :—**

Fertilizer	...	27
Various uses	...	28
Poluting of Rivers	...	28
Use of Potassic Content	...	28
Utility of Potash in Plant life	...	29
Extraction of Potash by Sugarcane	...	29
Percentage Potash in Molasses	...	29
Desi Canes	...	78
Cultivation of Medium Cane	...	81

Diseases of stem :—

Red Rot	...	83,84
Pine-apple disease	...	85
Dongkellan Disease	...	87
Bibit rot	...	87
Gumming disease	...	88
Sereh	...	92

Diseases of root :—

Eye Spot disease	...	93
Red Rot	...	94

Disease of the leaf—

Djamor—Oepas	...	94
Yellow spot disease	...	95
Rust	...	95
Ring spot disease	...	96
Eye spot disease	...	96
Yellow stripe disease	...	96

Diseases of root

Root Rot	97, 98, 99
----------	------------

E.

Estimated yield of ash product	...	37
Earthing of cane	...	76

F.

Fertilizer	...	5. 7
Fuel	...	5, 8
Filter Press Cake	...	29
Contents	...	29
Mixing with Ash Product	...	29

G.

General use of Molasses	2, 40, 41
-------------------------	-----------

H.

High Calorific Value of Molasses	... 47, 48
-------------------------------------	------------

I.

Importance of keeping the cane standing	... 75
Introduction of the cultivation of improved canes	76
Improved cultivation of Desi canes	... 78

L.**Land :—**

Ready for sowing	... 79
Preparation	... 80

M.**Molasses :—**

Production	... 2
Consumption	... 2
Composition	... 3, 13
Xanthin bodies	... 4
Carmelization product	... 4
Methylated spirit	... 5
Cattle Food	... 5
Production of yeast	... 5
Fertilizer	... 5
Road surfacer	... 5

Cheap confectionary	...	5
Fuel	...	5
Power Alcohol	...	5
Manufacture of Motor Fuel from Molasses	...	11
Existing Factories	...	11
Usual process adopted	...	11
Plant for the production	...	11
Preparation of yeast	...	12
Fermentation Wash	...	12
Distillation of Alcohol	...	12
Conversion of Alcohol into ether	...	12
Motor Spirit Distillery	...	26

O.

Operation of plant used for Molasses as Fertilizer		35
--	--	----

P.

Production of yeast	...	5
Power Alcohol	...	8
Promising outlet	...	8
As Fuel	...	8
Mixing with Petrol	...	8
Use in other countries	...	8
Plant for burning Molasses	...	31
Furnace	...	32
Distributing Drum	...	32
Use of damper	...	32

R.

Road surfacer	...	5, 7
---------------	-----	------

References :—Molasses.

By-product General	...	39
Alcohol	...	42
Yeast	...	45
Fuel	...	46
Fertilizer	...	48

Feeding stuff	...	49
Potash	...	50
Carbon	...	51
Cyanide	...	51
Desaccharification	...	51

S.**Specification :—**

Distillery	...	15
Wash	...	15
Ferments	...	16
Alcohol—Ether Mixture	...	17
Alcohol	...	19
Acid and Alkali	...	20
Accessories	...	20
Specification for Absolute Alcohol Wash	...	23
Ferments	...	23
Absolute Alcohol	...	23

T.**Trench cultivation :—**

Method	...	66, 67
Stimulation	...	66
Time period	...	67
Sizes	...	68
Digging	...	69
Manuring	...	70
Oil cake	...	71
Watering	...	72
Seedling	...	73

W.

Wash	...	13
Preparation	...	13
Heating	...	13
Pumping	...	13
Working cost of the production of Ash from Molasses	...	37

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